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Research paper

Maternal attachment state of mind and perinatal emotional wellbeing: Findings from a pregnancy cohort study

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ABSTRACT

Objectives: Maternal attachment state of mind is an important potential predictor of risk and resilience to perinatal emotional wellbeing and early parenting. To explore maternal attachment in relation to perinatal depression and emotional wellbeing.
Methods: This study drew on data collected within an ongoing cohort from 170 women recruited in early pregnancy, including 67 who met criteria for Major Depression. Maternal attachment state of mind was assessed with the Adult Attachment Interview (AAI) in pregnancy. Additional measures included the Structured Clinical Interview for the DSM (SCID), at 12 months the Strange Situation Procedure (SSP), Child Trauma Questionnaire (CTQ), Parenting Stress Index, and antenatal maternal hair cortisol concentrations (HCC).
Limitations: Sample size to be able to undertake all analyses using the 4 way classifications, cortisol measurement is limited to hair only and there is no prospectively collected measure of childhood trauma in mothers.
Conclusions: This study found that maternal attachment, specifically the Non-Autonomous states of mind, adjusted for clinical depression, was associated with higher cortisol in pregnancy and higher depressive symptoms across pregnancy and the postpartum. Furthermore, separately those with depression and Non-Autonomous states of mind also had higher postpartum parenting stress. There was no significant intergenerational concordance between AAI and SSP attachment classifications. Our findings support future research exploring the role of maternal attachment state of mind in understanding perinatal depression and emotional wellbeing.

1. Background

While parenting begins in pregnancy, it is thought that experiences that precede pregnancy may have influences on perinatal emotional wellbeing. Important factors associated with perinatal emotional wellbeing, includes stress, parenting and mental health. There has been a number of studies demonstrating the importance of a mother's own early life experiences, particularly those associated with trauma and neglect, in predicting her emotional wellbeing, including her mental health, in addition to her current expereince of parenting her infant during the perinatal period, usually defined as from conception to 12 months postpartum (Galbally et al., 2022a; Heim and Nemeroff, 2001; Moog et al., 2022). There is a number of ways to explore a mother's early life experience and the parenting she received as a child and most measures, such as the Childhood Trauma Questionnaire or the Parental Bonding Instrument, rely on self-report questionnaires, with concerns of bias in recall when required to provide autobiographical memory (Duyser et al., 2020; Kuyken and Dalgleish, 1995).

The Adult Attachment Interview (AAI) measures attachment state of mind through a semi-structured clinical interview that is transcribed verbatim and coded on the capacity to integrate episodic as well as semantic memories of experiences with their parents focused on attachment related events. In coding both the organisation and coherence of the narrative are important. The predominant mode of coding the AAI

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uses a classification of adult attachment in four categories, 'secure autonomous', 'insecure dismissing', 'insecure preoccupied', and 'unresolved/disorganised' (Main et al., 2002). The AAI has demonstrated stability in adult life, however fewer studies collect this measure in pregnancy (Bakermans-Kranenburg and Van IJzendoorn, 1993; Fonagy et al., 1991; Sagi et al., 1994). Furthermore, an intergenerational focus was limited to 23 studies identified within the meta-analysis undertaken by Verhage et al. that examined the AAI and included follow up with measures of infant-parent attachment (Verhage et al., 2016). While attachment state of mind is not a measure of either maternal experiences of parenting or childhood trauma it does reflect the capacity to reflect, organise and describe her early caregiving experiences and attachment relationship with her parents (Steele and Steele, 2008). This measure can provide an important window into understanding the current and ongoing influence of her early attachment relationships on the development of her relationship with her own infant, her response to stress both in pregnancy and subsequently in parenting as well as her perinatal mental health.

Indeed, maternal attachment state of mind has been previously explored as a potential predictor of risk and resilience to poorer mental health as well as the quality of the infant-parent attachment in the perinatal period (McMahon et al., 2008). In this study of 127 mothers assessed in the postpartum, insecure attachment state of mind predicted both chronicity of depression and insecure infant-parent attachment (McMahon et al., 2008; McMahon et al., 2006). This study exclusively examined women in the postpartum and included women without current depression as well as women with both brief and chronic depression in the postpartum. A subsequent larger study, as well as our own previous findings, have not found an association between maternal depression and insecure or disorganised infant-parent attachment, but neither study examined maternal attachment state of mind (Galbally et al., 2022b; Tharner et al., 2012).

In a recent study of 71 women and their children, the AAI was conducted in pregnancy and depressive symptoms measured using the screening measure Edinburgh Postnatal Depression Scale (EPDS) were collected in pregnancy and the postpartum together with both Parenting Stress Index in the postpartum and infant parent attachment using the Strange Situation Procedure. This study found both depressive symptoms and parenting stress were associated with an increased likelihood of insecure maternal attachment state of mind and insecure infant-parent relationship (Sechi et al., 2021). This study did not utilise a diagnostic measure of depression or draw on a clinical sample.

Outside of the perinatal period, a recent meta-analysis found that those with insecure attachment, specifically insecure-preoccupied, as well as those classified as unresolved on the AAI were more vulnerable to depression (Dagan et al., 2018). Given the potential association between maternal attachment state of mind and perinatal depression, a further exploration using both categorical and dimensional measures for depression is now warranted. In addition, depression is heterogenous and other associations are important in understanding depression specifically in the perinatal period. These potential predictors include maternal antenatal stress such as measured in hair cortisol concentration across pregnancy to ascertain stress, parenting stress, as well as infant-parent attachment (Galbally et al., 2019a; Galbally et al., 2019b; Galbally et al., 2021b; Galbally et al., 2022b).

As such, in this study we firstly examine associations between adult attachment states of mind assessed using the Adult Attachment Interview and maternal stress measured using maternal hair cortisol concentrations during pregnancy, perinatal depressive symptoms, and early parenting stress. Secondly, we assess the intergenerational concordance between classifications of adult attachment states of mind using the Adult Attachment Interview and infant-mother attachment security using the Strange Situation Procedure. Thirdly, we test if major depression during pregnancy and the early postpartum and a history of childhood trauma are moderators of intergenerational concordance of attachment. As only few studies have been conducted in this area, we consider ours as hypotheses-generating and exploratory.

2. Method

2.1. Sample

A sample of 170 women were drawn from a prospective pregnancy cohort, the Mercy Pregnancy and Emotional Wellbeing Study (MPEWS) based in Australia (Galbally et al., 2017). MPEWS is a targeted cohort, recruiting women taking antidepressant medication during pregnancy, women who meet criteria for a depressive disorder and not taking antidepressant medication, and a healthy control group. Only women in the cohort who had completed an Adult Attachment Interview were eligible for inclusion in the analyses. There were 67 women with a major depression diagnosis, comprising 56 (83.6 %) women who met diagnostic criteria for major depression when assessed at early pregnancy and 11 (16.4 %) women who met criteria for an episode of major depression between early pregnancy and six months postpartum when assessed at six months postpartum. Women provided informed, written consent before participating in the study and ethical review and approval was provided by the Mercy Health Human Research Ethics Committee.

2.2. Measures

2.2.1. Maternal depression

At recruitment at <20 weeks of pregnancy and repeated at 6 months postpartum, the Structured Clinical Interview for DSM-IV (SCID-IV) was administered (First et al., 1997). Women who met diagnostic criteria for a major depressive episode occurring during pregnancy and the first 6 months postpartum (coded 1) were compared against women who did not meet diagnostic criteria for major depression during this period (coded 0). Depressive symptoms were measured using the EPDS (Cox et al., 1987), which has been validated for use with Australian women during the perinatal period (Boyce et al., 1993).

2.2.2. Maternal attachment

Maternal state of mind with regard to attachment was assessed using the Adult Attachment Interview (AAI) conducted during early pregnancy up to 20 weeks gestation (George et al., 1996). The AAI is a semi-structured interview comprising a set of 20 questions and suggestions for follow up exploring the interviewee's perception of childhood experiences with parents, experiences of abuse and loss, and the impact of these experiences on their current relationship with their parents. The interview is thought to create conditions that direct attention towards attachment-related experiences and is coded for the speaker's ability to integrate episodic (i.e., specific events) and semantic (i.e., certain beliefs) information. Patterns in the way interviewees talk about attachment experiences are thought to reflect the speaker's state of mind with respect to attachment autonomy. Using several subscales according to the Main and colleagues' manual, transcripts can be classified into one of four attachment classification: Insecure dismissing (D), secure autonomous (F), insecure preoccupied (E), and unresolved/disorganised (U). Binary classifications of attachment autonomy (D, E and U = 0 and F = 1) unresolved/disorganised (D, E and F = 0 and U = 1) can also be derived (Main et al., 2002). There were two certified reliable coders for the AAI. Ten of the 170 AAIs were coded by both coders as one coder only coded 38 interviews. Using the 4-way DFEU classification for the AAI, there was 90 % agreement (kappa = 0.63, $p = .008$) between the two coders, and for AAI Security (Secure/Insecure) and AAI Unresolved (not U/U) as binary categories, there was 90 % agreement between coders for both (AAI Security: kappa = 0.62, $p = .035$; AAI Unresolved: kappa = 0.61, $p = .047$).

2.2.3. Infant-mother attachment

Infant-mother attachment security was measured using the Strange

Situation Procedure (SSP) at 12 months of age (Ainsworth et al., 1978). The SSP is an observational laboratory procedure utilizing a standardized protocol of eight 3-minute episodes of separation and reunion with the mother. The procedure should act as a mild stressor for the child and is designed to activate attachment behaviours. The separation episodes were curtailed when the infant was too distressed about the parent's absence; this was defined as showing physiological signs of distress or prolonged distress and no infant was left distressed for more than one minute not resolving. The SSP is coded for three organized patterns of attachment: secure (B), insecure-avoidant (A), and insecure-ambivalent (C). Attachment disorganisation (D) was coded using the Main and Solomon coding system (Main and Solomon, 1990). Richter's continuous security scale was also calculated using continuous attachment interactive scales, but without infant crying and respective discriminant functions reported in van IJzendoorn and Kroonenberg (Van Ijzendoorn and Kroonenberg, 1990). Richter's scores equal to 0 and higher suggest secure attachment, whereas Richter's scores below zero suggest insecure attachment. Consistent with van IJzendoorn and Kroonenberg, the derived Richter's security score without crying was able to predict secure versus insecure dyads with 90.5 % accuracy in our sample. All SSPs were coded by two certified reliable coders. Inter-rater reliability (kappa statistic) between these two coders was 0.64 for the 4-way classification, and the ICC was 0.49 for the Richter's security and 0.61 for the continuous disorganisation single measures scores. Following initial assessment of inter-rater reliability, both coders engaged in discussions to arrive at a consensus for each case where there was a disagreement between codes.

2.2.4. History of maternal childhood trauma

Maternal childhood trauma history was measured using the brief version of the Childhood Trauma Questionnaire (CTQ), which is a 28-item self-report measure (Bernstein et al., 2003). Previously, in this cohort, the total CTQ and each of the five subscales (emotional abuse and neglect, physical abuse and neglect, and sexual abuse) have demonstrated adequate to strong internal consistency, with Cronbach's alphas ranging 0.75 to 0.92 (Galbally et al., 2019b). In this study, we dichotomised the total CTQ score because of the positively skewed reports of CTQ. Responses were dichotomised using severity cut-off scores provided by the CTQ manual to create binary groups (0 = None-to-Minimal, 1 = Moderate-to-Severe) (Bernstein et al., 2003).

2.2.5. Parenting stress

At six and 12 months postpartum, stress due to the roles of parenting was assessed using the fourth edition Parenting Stress Index, Short-form (Abidin, 2012). The 36-item PSI-4-SF divides into three subscales (Difficult Child, Parent Distress, and Parent-child Dysfunctional Interactions) and provides percentiles for comparison across studies. Due to strong concurrent associations between the Parent Distress subscale and the EPDS, we used only the Parent-Child Dysfunctional Interactions and Difficult Child subscale percentile scores.

2.2.6. Maternal antenatal cortisol

As previously described for this cohort, a length of maternal hair of approximately 20 g (150 strands) was collected on day 1 post-delivery, which allows to retrospectively provide average cortisol across pregnancy, in addition infant hair was also collected at 12 months postpartum and analyzed for cortisol (Galbally et al., 2019a; Manenschijn et al., 2011; Smy et al., 2016). A questionnaire related to factors potentially influencing HCC was administered and as previously reported both bleaching and treating hair during pregnancy and for the infant at 12 months was not associated with differences in hair cortisol concentrations (HCC) (Galbally et al., 2019a). At least 5 mg of the most proximal 3 cm of hair was weighed for each hair sample and samples were collected, processed and analyzed as previously described (Galbally et al., 2019a; Noppe et al., 2015). Hair cortisol was quantified by liquid chromatography - tandem mass spectrometry using a Xevo TQ-S system (Waters, Milford MA) (Galbally et al., 2019a; Noppe et al., 2015). Higher concentrations of cortisol indicate higher levels of stress.

2.2.7. Statistical analyses

To examine associations between adult attachment autonomy with maternal stress during pregnancy using HCC, perinatal depressive symptoms using EPDS, and early parenting stress using the PSI, we fit a series of linear mixed effects regression models. In each model, time was modelled as a continuous fixed and random effect. To test both maternal childhood trauma and major depression as moderators of the associations between adult attachment autonomy with pregnancy stress, perinatal depressive symptoms, and postpartum parenting stress, multiplicative interaction terms were modelled. Only significant interactions were retained in the reported models, with significant terms probed by the plotting and testing of simple effects.

To assess the intergenerational concordance between maternal classifications of adult attachment states of mind and mother-child attachment security, kappa tests of categorical agreement were conducted between distributions of the 4-way AAI and SSP classifications, between the AAI Autonomy and SSP Security classifications, and between the AAI Unresolved and SSP Disorganisation classifications. To test both maternal childhood trauma and major depression as moderators of intergenerational concordance of attachment, further kappa tests were conducted stratified by childhood trauma and major depression groups. All analyses were conducted using Stata 16.

3. Results

Table 1 displays demographics and key characteristics of the sample. Women were almost exclusively nulliparous, in a committed relationship and of Oceanic/European ethnicity. Women in this sample were an average of 31.14 years of age (SD = 5.19). There were no significant differences between women with and without depression across the sociodemographic characteristics reported.

3.1. Maternal mental health by adult attachment autonomy

Table 2 displays unadjusted differences in maternal depression, trauma, and mental health variables by AAI Autonomy (Secure Autonomous (F) and Insecure/Disorganised Not Autonomous (D, E and U) groups). There were significant differences between the Autonomy groups in two domains of childhood trauma (p's < 0.05). Specifically, more women in the Not Autonomous group compared to Autonomous group reported moderate-to-severe physical (34.4 % c.f. 13.9 %) and sexual abuse (50.0 % c.f. 30.0 %). Autonomy groups did not differ in the

Table 1
Sample sociodemographic, mental health and attachment characteristics (N = 170).

	n	%[a]
Oceanic/European ethnicity (missing = 1)	152	89.9
University education (missing = 3)	104	62.3
Married, de facto, or otherwise stable relationship (missing = 16)	145	94.2
Nulliparous	164	96.5
Major depression	67	39.4
Antidepressant use during pregnancy	46	27.1
History of moderate-to-severe childhood trauma (missing = 16)	59	38.3
AAI		
D: Insecure dismissing	20	11.8
F: Secure autonomous	129	75.9
E: Insecure preoccupied	8	4.7
U: Unresolved/disorganised	13	7.6
SSP (missing = 34)		
A: Insecure-avoidant	22	16.2
B: Secure	80	58.8
C: Insecure-ambivalent	7	5.1
D: Disorganised	27	19.9

[a] Valid percentages reported. Missing data handled using case-wise omission.

Table 2
Unadjusted differences between maternal variables by adult attachment autonomy ($N = 170$).

	Not autonomous ($n = 41$, 24.1 %)		Autonomous ($n = 129$, 75.9 %)		Fisher's exact *p*-value
	n	%	*n*	%	
Moderate-to-severe maternal childhood trauma					
Emotional abuse	15	46.9	35	30.7	.088
Physical abuse	11	34.4	16	13.9	.008
Sexual abuse	16	50.0	33	30.0	.036
Emotional neglect	15	45.5	44	38.3	.457
Physical neglect	8	24.2	16	13.8	.150
Maternal history of moderate-to-severe total childhood trauma	17	50.0	42	35.0	.112
Maternal depression in early pregnancy (SCID-IV)	16	39.0	40	31.0	.341
Antidepressant use during pregnancy	11	26.8	35	27.1	.970
	M	*SD*	*M*	*SD*	*p*-Value
Maternal age in early pregnancy	30.76	5.99	31.26	4.93	.593
Hair cortisol concentration					
First trimester	10.92	16.47	7.01	11.51	.222[a]
Second trimester	13.31	18.62	8.26	13.74	.154[a]
Third trimester	13.01	16.46	7.12	8.76	.052[a]
Depressive symptoms					
Early pregnancy	8.97	6.60	6.42	4.47	.028[a]
Third trimester	7.89	6.09	6.62	4.39	.238[a]
Six months postpartum	8.00	5.98	6.02	4.73	.062
12 months postpartum	7.81	6.69	6.65	4.68	.441[a]
Parenting stress					
Six months postpartum	28.02	23.93	28.43	19.80	.924
12 months postpartum	34.41	23.62	31.43	21.72	.564

Missing data handled using case-wise omission. SCID-IV, Structured Clinical Interview for the DSM-IV.
[a] Welch's F test results due to heterogeneity of variances.

HCC cross-sectionally during the first and third trimesters. Other than significantly higher depressive symptoms during early pregnancy, women in the Not Autonomous group compared to the Autonomous group did not differ significantly in depressive symptoms and parenting stress at all other cross-sectional timepoints, nor were there any significant differences between the groups in the prevalence of major depression and antidepressant use during pregnancy. Unadjusted differences in maternal depression, trauma, and mental health variables across the 4-way DFEU AAI classification can be found in the Supplementary file.

3.1.1. Maternal autonomous states of mind and maternal mental health

Table 3 displays the fixed effects estimated by the mixed linear regression models predicting: HCC at first, second and third trimesters during pregnancy; depressive symptoms at early pregnancy, third trimester, and six and 12 months postpartum; and parenting stress at six and 12 months postpartum.

For the pregnancy HCC model, there was a significant positive effect of trimester, such that HCC increased significantly, on average, during pregnancy for all women (i.e., no significant interaction between attachment Autonomy and trimester). There were also no significant interactions between Autonomy with maternal history of moderate-to-severe childhood trauma and major depression. After adjusting for maternal history of moderate-to-severe childhood trauma, major depression and stressful life events during pregnancy, an Autonomous state of mind was associated with significantly lower pregnancy HCC. These results suggest that although HCC increases during pregnancy for all women, women with Non-Autonomous states of mind had

Table 3
Fixed estimates for mixed linear regression models predicting repeat-measurement maternal mental health outcomes ($N = 170$).

	b	*SE*	*95 % CI*
Pregnancy HCC model			
Intercept	1.85	0.25	1.36, 2.33
Trimester	0.14***	0.03	0.08, 0.21
History of moderate-to-severe childhood trauma	−0.19	0.2	−0.57, 0.19
Major depression	−0.23	0.18	−0.59, 0.12
Number of stressful life events during pregnancy	0.05	0.05	−0.04, 0.14
AAI Autonomy	−0.62**	0.22	−1.05, −0.18
Perinatal depressive symptoms model			
Intercept	3.64	1.15	1.38, 5.90
Timepoint	−0.13	0.15	−0.43, 0.17
History of moderate-to-severe childhood trauma	2.41***	0.61	1.22, 3.60
Major depression	5.06***	1.22	2.67, 7.44
Number of stressful life events during pregnancy	0.60***	0.14	0.32, 0.88
Average maternal HCC during pregnancy	0.13	0.25	−0.36, 0.61
AAI Autonomy	0.38	1.02	−1.62, 2.38
Major depression * AAI Autonomy	−2.67*	1.36	−5.35, −0.01
Postpartum parenting stress model			
Intercept	14.81	6.86	1.37, 28.25
12 months postpartum c.f. 6 months postpartum	3.45*	1.75	0.01, 6.88
History of moderate-to-severe childhood trauma	−2.04	3.39	−8.69, 4.61
Major depression	3.17	3.33	−3.37, 9.70
Number of stressful life events during pregnancy	−1.13	0.88	2.85, 0.59
Average maternal HCC during pregnancy	−1.91	1.4	−4.65, 0.82
AAI Autonomy	7.73	6.02	−4.07, 19.53
Depressive symptoms	2.24***	0.52	1.23, 3.25
Depressive symptoms * AAI Autonomy	−1.26*	0.58	−2.40, −0.11

Notes. Trimester is modelled continuously in the Pregnancy HCC model with 0 = 1st trimester, 1 = 2nd trimester, 2 = 3rd trimester. Timepoint is modelled continuously in the Perinatal Depressive Symptoms model with 0 = early pregnancy, 1 = 3rd trimester, 2 = six months postpartum and 3 = 12 months postpartum. Depressive symptoms in the Postpartum Parenting Stress model are time-varying with the outcome.
Abbreviations: b, regression coefficient; SE, standard error; CI, Confidence interval; HCC, Hair cortisol concentrations; AAI, Adult attachment interview.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

significantly higher average HCC throughout pregnancy.

Perinatal depressive symptoms were flat, on average, across the perinatal period (see Table 3). There were no significant interactions between Autonomy with timepoints, maternal history of moderate-to-severe childhood trauma and average pregnancy HCC. There was, however, a significant interaction between Autonomy and major depression ($p = .049$). The interaction is depicted in Fig. 1 showing that although the association between major depression and average perinatal depressive symptoms is significant for women who demonstrated an Autonomous state of mind ($b = 2.38$, $p < .001$), the association was strongest for women demonstrating a Non-Autonomous state of mind ($b = 5.06$, $p < .001$).

For the postpartum parenting stress model, average parenting stress increased significantly between six and 12 months postpartum (see Table 3). Despite the average increase during the postpartum, this association did not vary by Autonomy (i.e., no significant interaction between Autonomy and postpartum timepoint). There were also no

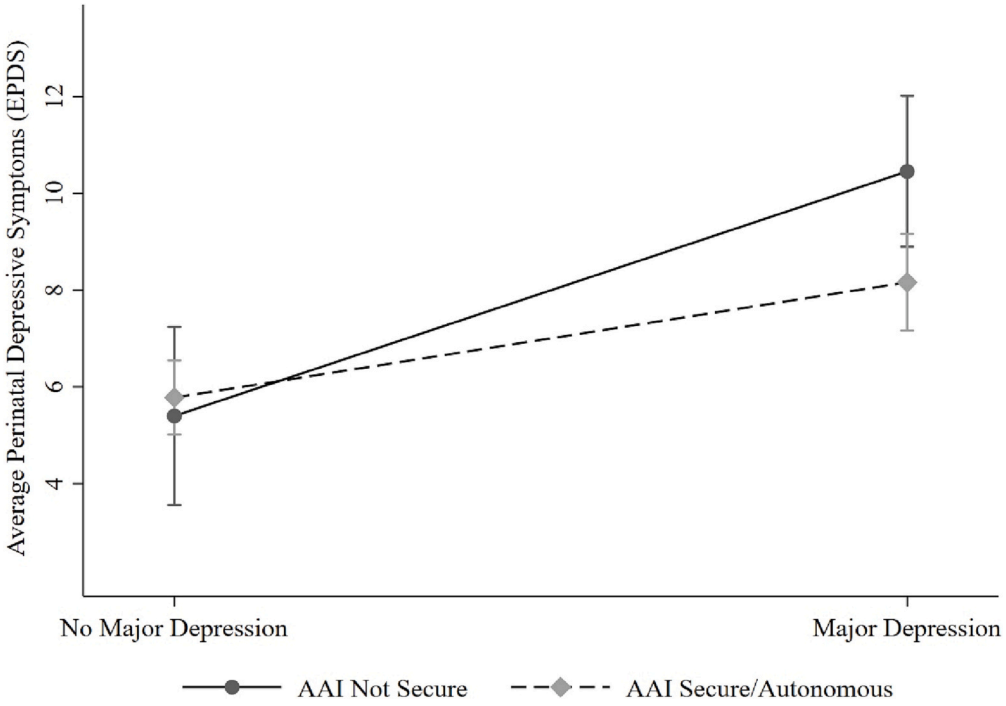

Fig. 1. Model-estimated simple slopes probing the significant interaction between autonomy and major depression in predicting perinatal depressive symptoms.

significant interactions between Autonomy with maternal history of moderate-to-severe childhood trauma, major depression, and average pregnancy HCC. However, there was a significant interaction between Autonomy and time-varying postpartum depressive symptoms (p = .026; see Fig. 2), such that although higher average postpartum depressive symptoms was a significant predictor of average postpartum parenting stress for women with an Autonomous state of mind ($b = 0.98$, $p = .002$), average postpartum depressive symptoms was a significantly stronger predictor of average postpartum parenting stress for women with a Non-Autonomous state of mind ($b = 2.24$, $p < .001$).

3.2. *Intergenerational concordance of attachment security*

Table 4 presents the concordance between AAI and SSP classification

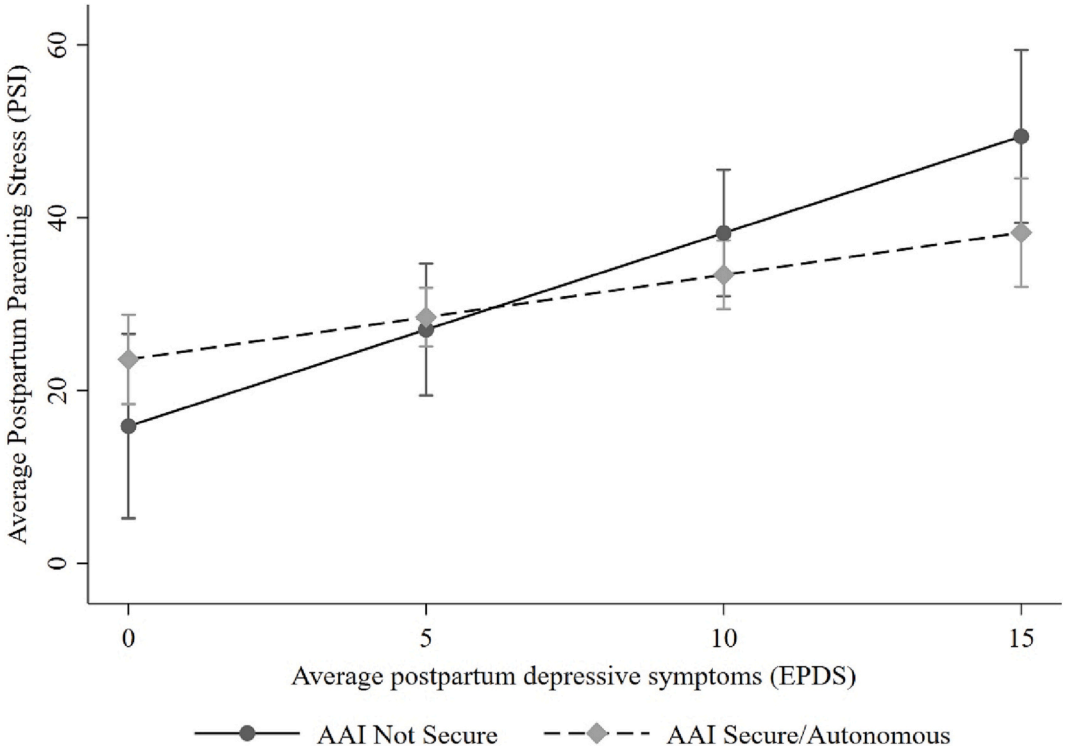

Fig. 2. Model-estimated simple slopes probing the significant interaction between autonomy and perinatal depressive symptoms in predicting postpartum parenting stress.

Table 4
Agreement between distributions of AAI and SSP 4-way classifications, AAI Autonomy and SSP security classifications, and AAI unresolved and SSP disorganisation classifications ($n = 136$).

SSP ABCD	AAI DFEU			
	D: Insecure dismissing	F: Secure autonomous	E: Insecure preoccupied	U: Unresolved/disorganised
	n (total %)	*n* (total %)	*n* (total %)	*n* (total %)
A: Insecure-avoidant	1 (1.9)	18 (13.2)	1 (0.7)	2 (1.6)
B: Secure	8 (5.9)	63 (46.3)	3 (2.2)	6 (4.4)
C: Insecure-ambivalent	0 (0.0)	6 (4.4)	1 (0.7)	0 (0.0)
D: Disorganised	3 (2.2)	21 (15.4)	1 (0.7)	2 (1.5)

SSP security	AAI Autonomy	
	Not autonomous	Autonomous
	n (total %)	*n* (total %)
Not secure	11 (8.1)	45 (32.1)
Secure	17 (12.5)	63 (36.3)

SSP disorganisation	AAI unresolved	
	Not unresolved	Unresolved
	n (total %)	*n* (total %)
Not disorganised	101 (74.3)	8 (5.9)
Disorganised	25 (18.4)	2 (1.5)

distributions. Only 67 of 136 women (50.4 %) demonstrated concordance between the 4-way AAI and SSP classifications (Fisher's exact $\chi^2 = 3.59$, $p = .717$, $kappa = -0.01$, $p = .890$), which was not significant. Similarly, 74 (54.6 %) women matched on their AAI Autonomy and SSP Security classifications ($\chi^2 = 0.05$, $p = .820$, $kappa = -0.02$, $p = .834$; $r = -0.02$ [95 % CI: −0.19, 0.15]). Compared with Verhage et al., who reported an effect size of $r = 0.14$ (95 % CI 0.06, 0.21), a two one-sided test of equivalence using the lower 95 % interval for the reported association between AAI Autonomy and SSP Security ($\Delta_L = 0.06$ and $\Delta_U = 0.21$) demonstrated the observed correlation in this study was not statistically equivalent to Verhage et al. (Verhage et al., 2018; Verhage et al., 2016). Due to the AAI Unresolved and SSP Disorganised classifications being unbalanced, concordance appears strong ($n = 103$, 75.8 %), but agreement between the two classifications was not significant (Fisher's exact $\chi^2 < 0.01$, $p = .990$, $kappa = 0.01$, $p = .990$). Stratifying for major depression and moderate-to-severe childhood trauma did not strengthen intergenerational concordance of attachment security within groups. Taken together, these results suggest that for this sample the AAI conducted in early pregnancy and the SSP conducted at 12 months postpartum are related no more strongly than chance.

4. Discussion

Our study found that maternal attachment state of mind, specifically Non-Autonomous representation, that is those with insecure or disorganised attachment, when adjusted for childhood trauma, stress and depression, was associated with higher cortisol in pregnancy. Non-Autonomous attachment in those with major depression in pregnancy was also associated with higher levels of depressive symptoms across the perinatal period, that is across pregnancy and the first 12 months postpartum, than those with Secure attachment state of mind and major depression. Furthermore, those with depression and Non-Autonomous state of mind also had higher postpartum parenting stress and in those with Non-Autonomous state of mind there was a stronger relationship between depressive symptoms and parenting stress. Overall, this suggests that maternal attachment state of mind may influence perinatal depression including chronicity of symptoms and the association with parenting stress as well as predict those with depression who also have higher antenatal cortisol as a measure of antenatal stress and postpartum parenting stress. This gives important direction to understanding the variation in findings for perinatal depression such as the association with elevated cortisol, which has been inconsistently found, but has important implications for both maternal and fetal outcomes (Galbally et al., 2021a; Seth et al., 2016; Seth et al., 2015). Our findings suggest the importance of maternal attachment of mind to distinguish those with depression who may be at greater risk of significant sequalae including chronic elevated depressive symptoms, elevated cortisol in pregnancy and parenting stress. Unsurprising was the direct association between maternal attachment state of mind and self-reported childhood trauma, in particular physical neglect, as although these measures represent distinct constructs (representations versus perceived experiences) our overall findings support the importance of measuring attachment state of mind in the perinatal period in addition to self-report measures of childhood trauma experiences.

Depression and attachment state of mind measured using the AAI has been examined in a recent meta-analysis and found Insecure as well as Unresolved attachment state of mind was associated with higher depressive symptoms (Dagan et al., 2018). However, very few studies utilised a diagnostic measure of depression and most were drawn from non-clinical samples (Dagan et al., 2018). The meta-analysis identified 3 studies that had utilised the SCID with sample sizes of 36–85, with 2 studies of women with young children and another in a sample unrelated to parenting, of these 3 studies there were 2 that found an association between depression and adult attachment state of mind (Dagan et al., 2018). Our data adds to this limited data with a larger sample size, use of a diagnostic measure SCID that confirms this is a clinical sample in addition to the screening measure of the EPDS to measure depressive symptoms across the perinatal period. Our study uniquely also included measures of antenatal cortisol, self-report trauma and parenting stress. Our findings support a previous study 127 women in the postpartum that also found a relationship between insecure attachment state of mind and postpartum depression, however they also found this moderated a relationship with infant-parent attachment (McMahon et al., 2006). This study did not measure mental health in pregnancy. In a recent study that utilised EPDS and AAI together with parenting stress found insecure attachment state of mind together with parenting stress was associated

with insecure infant-parent attachment (Sechi et al., 2021). We found attachment state of mind and depression was associated with parenting stress, but did not find an association with infant-parent attachment. Future research is needed to clarify relationships between attachment state of mind and maternal depression and how this might predict parenting stress, infant attachment as well as other child socio-emotional and developmental outcomes and in particular if there are additional factors that are involved in any pathway.

Few studies have examined AAI and cortisol levels and none that we could identify have examined it in pregnancy using hair cortisol concentrations. The advantages of hair cortisol concentrations are that they provide average cortisol over several months of pregnancy rather than be vulnerable to diurnal variation or transient stressors that might impact salivary or other forms of measurement. The studies outside of pregnancy have found that cortisol can be both increased or decreased depending on the impact, complexity and chronicity of trauma exposure (Pierrehumbert et al., 2012; Pierrehumbert et al., 2009). Our findings suggest the importance of further exploration of the relationship between attachment state of mind and stress regulation such as through hair cortisol concentrations. Maternal cortisol levels in those with depression have been associated with changes in placental regulation of cortisol exposure of the fetus and as such understanding any role of attachment state of mind in this pathway could be important in elucidating fetal programming pathways for later child vulnerability to poorer socioemotional development (Galbally et al., 2021a; O'Donnell et al., 2011; Seth et al., 2015).

Our study found the distribution of the AAI 4-way DFEU classifications in this sample was strongly weighted towards F: Secure Autonomous (75.9 %), which is in contrast to Bakermans-Kranenburg and van IJzendoorn, where overall for the 'clinical risk' sample, which included trauma, mental health, violence/abuse and disability, the Unresolved/Disorganised was the most prevalent classification (43 %) (Bakermans-Kranenburg and van IJzendoorn, 2009). However, for those included from studies of depression ($n = 205$), Secure Autonomous was the most prevalent at 31 % and Unresolved/Disorganised was 22 % (Bakermans-Kranenburg and van IJzendoorn, 2009). The difference in our sample may reflect this a socio-economically advantaged sample who do not have multiple social risk factors, allowing us to examine the relationship specifically to clinical depression. Our study did not find significant concordance between AAI and SSP attachment classification and this was not improved when stratifying for major depression and childhood trauma. While other studies have found concordance it has been noted to be lower in clinical high-risk samples although no study that we are aware of have examined this in a study with a clinical mental health sample (Verhage et al., 2016). Previous studies that have shown concordance have predominantly been in community samples. For example, the first study to examine late pregnancy maternal attachment as a predictor of infant-parent attachment found within a sample of 100 women and children for two-way classification 75 % concordance and for three-way classification 66 % concordance with the AAI classifications of dismissing, autonomous and preoccupied with SSP ABC or B and non B classifications suggesting strong support for intergenerational transmission of attachment beginning in the womb (Fonagy et al., 1991).

There are many strengths to our study including the careful measurement of depression, the inclusion of a biological measure of stress as well as the use of both the AAI and SSP to measure attachment. There are also limitations including the overall sample size that precluded use of all 4 categories of attachment in all of the analyses, we also do not have any objective verification of childhood adverse experiences and rely on recall through interview or self-report which may be subject to recall bias. We also only include an average hair cortisol concentration and do not include a measure of cortisol reactivity or responsiveness to stress. Finally, the inter-rater reliability (kappa statistic) between the two coders for the SSP achieved moderate rather than strong or near perfect agreement. There is the possibility this may have an influence on the findings.

These findings confirm the association between maternal attachment state of mind and depression and further highlight the importance of considering this across the perinatal period. They also demonstrate that if we are to understand some of the earliest risk factors from pregnancy onwards around mental health including a measure not only of the quality of the parent-infant relationship but also of the attachment state of mind in the parent is of great value in our endeavour to elucidate the critical risk and protective factors of early life.

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CRediT authorship contribution statement

MG obtained funding for the overall study including reported in this paper, obtained ethics approvals, led the overall study protocol and oversaw data collection for this study and contributed to conceptualization and drafting the paper, revising and final editing, SW undertook the statistical analysis and contributed to drafting the paper, AL contributed to the overall study protocol and funding, data collection for this paper, revising and editing this paper, MvIJ contributed to the overall study protocol and funding, conceptualization of this paper and revising and editing this paper. All authors reviewed, edited and have approved the final paper submitted.

Declaration of competing interest

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

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