Maternal and Child Health Journal (2019) 23:1686–1698
https://doi.org/10.1007/s10995-019-02809-1

Mother–Infant Bonding and Emotional Availability at 12-Months of Age: The Role of Early Postnatal Bonding, Maternal Substance Use and Mental Health

Larissa Rossen[1] · Richard P. Mattick[1] · Judy Wilson[1] · Philip J. Clare[1] · Lucinda Burns[1] · Steve Allsop[2] · Elizabeth J. Elliott[3] · Sue Jacobs[4] · Craig A. Olsson[5,6,7] · Delyse Hutchinson[1,5,6,7]

Published online: 16 September 2019

Abstract

Introduction The quality of the mother–child relationship in the first year of life has far reaching implications across the life course (Bornstein in Annu Rev Psychol 65:121–158, 2014). Yet little is known about predictors of maternal bonding and emotional availability in early infancy. In this study we examined the extent to which postnatal bonding, maternal mental health, and substance use at 8-weeks postpartum predicted mother–infant bonding (self-report) and mother emotional availability (observational) at 12-months of age.

Methods Data were obtained from an Australian longitudinal cohort study of pregnancy (n = 308). Data were collected during pregnancy, at birth, and postnatally at 8-weeks and 12-months.

Results The results show strong continuity between postnatal bonding at 8-weeks and 12-months. Early postpartum stress and depression were associated with bonding at 12-months; however, the effect did not persist after adjustment for bonding at 8-weeks. Tobacco use at 8-weeks, but no other indicators of mental health, predicted lower emotional availability scores at 12-months.

Discussion Results suggest that the mother's felt bond to her child is stable across the first year of life and that early bonding is a more robust indicator of bonding at 12-months than a mother's mental health or substance use. These findings point to the importance of clinical and public health investments in establishing a strong bond between mother and child in the early postpartum period.

Keywords Maternal bonding · Emotional availability · Postnatal period · Mental health · Substance use · Mother–child relationship

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s10995-019-02809-1) contains supplementary material, which is available to authorized users.

✉ Larissa Rossen
l.rossen@unsw.edu.au

[1] National Drug and Alcohol Research Centre, University of New South Wales, Sydney, Australia

[2] National Drug Research Institute, Curtin University of Technology, Perth, Australia

[3] Paediatrics and Child Health, Sydney Medical School, University of Sydney, Sydney, Australia

[4] Department of Obstetrics, Royal Prince Alfred Hospital, Sydney, Australia

[5] Centre for Social and Early Emotional Development, School of Psychology, Deakin University, Geelong, Australia

[6] Centre for Adolescent Health, Murdoch Childrens Research Institute, Parkville, Australia

[7] Department of Paediatrics and Psychological Sciences, Royal Children's Hospital, University of Melbourne, Melbourne, Australia

Significance

What is already known on this subject? The importance of the mother–child relationship for later development has been demonstrated. Yet exceedingly little is known about the factors that predict the quality of this relationship during early infancy. This study draws on unique Australian longitudinal data to examine early postnatal predictors of maternal–infant bonding quality at 12 months of age.

What this study adds? This work adds to the extant literature by using rare longitudinal data spanning the beginning and end of the first year of life to examine predictors of maternal bonding and emotional availability at 12-months post-birth. The study includes self-report and observational assessments of the mother–child relationship, and controls for a range of sociodemographic and postnatal variables. Findings suggest that maternal bonding is stable across the first year of life and that early postnatal bonding is a more robust indicator of bonding at 12-months than the mother's mental health or substance use.

Introduction

The quality of the relationship between a mother and her infant is a well-established determinant of psychosocial adjustment and maladjustment in later life (Bornstein 2014). Two key aspects of the mother–infant relationship are the maternal *bond* and *emotional availability* (EA). Mother–infant bonding refers to how a mother feels toward her child, and the extent to which she provides protection, comfort, and care to her infant (Ainsworth and Bell 1972). EA refers to the extent to which a mother–infant dyad shares an emotional connection and enjoys a mutually fulfilling relationship (Biringen and Easterbrooks 2012). Both aspects—the bond and EA—are important for children's health and development. For example, a healthy maternal-bond supports infant health and wellbeing, including later cognitive and socio-emotional development, physical health, and inter-personal relationships (Johnson 2013). Similarly, EA has been shown to predict offspring emotion regulation and school readiness (Saunders et al. 2015).

Maternal Bonding

Research has demonstrated links between early and later bonding across infancy. In a study of 372 mother–infant dyads, higher antenatal bonding, assessed at three time-points during pregnancy, subsequently predicted higher postnatal bonding on the Maternal Postnatal Attachment Scale (MPAS) at 8-weeks post-birth (Rossen et al. 2016). In another prospective study of 200 mother–infant dyads, bonding at 4-weeks postnatal was associated with later bonding at 4- and 8-months postnatal, also using the MPAS (Condon and Corkindale 1998). Early bonding has also been shown to predict later bonding at 12-months postpartum using the Mother–Infant Bonding Scale (MIBQ) in a study of 50 mothers suffering depression and 29 controls (O'Higgins et al. 2013).

Emotional Availability

Compared to the bond, EA provides a *transactional* view of the mother–infant relationship (Sameroff and Fiese 2000), whereby both the mother and the infant's contribution to the relational interaction are assessed (Biringen et al. 2014). Although EA has been studied extensively in relation to infant attachment (Altenhofen et al. 2013; Altenhofen et al. 2010), including the Strange Situation protocol (Aviezer et al. 2003, 1999; Biringen et al. 2005; Carter et al. 2001; Easterbrooks et al. 2000; Ziv et al. 2000), no longitudinal studies of which we are aware have identified the key predictors of EA in early infancy (12-months), whilst also taking into account other potentially important factors (e.g., demographic, postnatal, mental health, and substance use factors).

Furthermore, there is a lack of studies that include examination of both *observed* parent–infant interactions and the mother's *self-reported* emotional bond to her infant. Variations in mode of assessment (i.e., self-report versus observational) may influence the way in which the parent–infant relationship is understood, with multi-method approaches hypothesised to provide a more rigorous assessment than one method alone (Vliegen et al. 2009). Therefore, a gap remains in understanding how self-reported bonding and EA each provide unique information about parent–infant relationship quality in the first year of life.

Mental Health

Anhedonia, low or dysregulated affect and reduced capacity to view the future positively have been theorised to interfere with the bonding process (Bornstein 2014). Feelings of stress and anxiety may also affect a mother's attunement to her infant, as these feelings may be markers of hypervigilance prompting a mother to focus attention away from the infant (Davies 2010; Thompson 2001). Research has supported this notion, particularly in studies that include at-risk dyads. For example, a study by Moehler and colleagues showed that maternal depressive symptoms postpartum were associated with lower quality maternal bonding (n = 101 mother–infant dyads) between 2 and 14 months of age (Moehler et al. 2006). A German sample of 78 mothers experiencing postpartum anxiety reported significantly lower bonding than non-symptomatic mothers when their

infants were 4-months of age (Tietz et al. 2014). Yet emerging evidence has shown that maternal bonding may be protective to the deleterious effects of elevated negative affect within the development of the mother–infant relationship during the first year of life. Indeed, early bonding, rather than depressive symptoms, has been associated with postnatal bonding at 1-year of age in a study of 50 depressed and 29 non-depressed mothers (O'Higgins et al. 2013). Likewise, another study found that maternal bonding buffered the negative impact of postpartum clinical depression on parenting stress among 31 mothers and 32 healthy controls (Reck et al. 2016). Taken together, the association between maternal mental health and the potential mediating effects of early bonding warrant further exploration.

Symptoms of depression, anxiety and stress can also manifest as emotion dysregulation, characterised by distorted thinking and impaired judgement. These characteristics can in turn impact parental *sensitivity* and *responsiveness* to the infant, both of which are key components of EA (Lefkovics et al. 2014). In support of this notion, one study of 56 mother–child dyads found that maternal anxiety was associated with reduced sensitivity, structure and child involvement in interactions with toddlers at 24-months; however these findings were limited to dyads in a neonatal intensive care unit (Zelkowitz et al. 2009). Lower EA scores have also been reported among women with depressive symptoms and their children at 7-years of age (Easterbrooks et al. 2000), women with clinical depression and their children at age 4-years (Trapolini et al. 2008), and women with diagnosed postpartum depression in the first year of life (Vliegen et al. 2009). In contrast, a number of contradictory studies found no differences in EA between clinically depressed and non-depressed women (Fonseca et al. 2010; Timmer et al. 2011). Somewhat surprisingly, a paucity of prospective research is available on the role of depressive, anxiety and stress symptoms on bonding and EA in general community samples of mother–child dyads. This gap is important to address, given that results of clinical populations may not generalise to the broader community.

Substance Use

Alcohol, tobacco or illicit drug use are also markers of affective dysregulation and may modify the intensity of a mother's feelings toward her infant, impacting on her capacity to build healthy emotional connections (Koole 2009; Sloan et al. 2017). Most research in the area of parent–infant relationships has focused on substance 'abuse', defined as the harmful or hazardous use of psychoactive substances including alcohol and illicit drugs (World Health Organization 2004). An integrative review of research literature on mother–infant interaction and maternal substance use/abuse found, in 14 of the 23 studies, maternal substance abuse was associated with a detrimental impact on mother–child interaction; although six studies found no relationship. In a study conducted in Finland, researchers found mothers with an alcohol or drug abuse problem tended to have more problems in their interactive behaviour with their infants at three and six months postpartum (Pajulo et al. 2001). Lower mother–infant EA has also been reported among mothers affected by illicit drug dependence (Espinet et al. 2013; Flykt et al. 2012; Fraser et al. 2010; Salo et al. 2009, 2010; Swanson et al. 2000).

Low-level substance use, however, is the most frequent pattern of use reported among pregnant Australian women (Hutchinson et al. 2013), and the majority of women who use substances like alcohol and tobacco prior to becoming pregnant tend to continue using these substances at low-levels postpartum (Hutchinson et al. 2013; McCormack et al. 2017). Yet literature examining more common substances (namely caffeine, alcohol, and tobacco use) in the early postnatal period (8-weeks) and the associations with mother–infant relationship quality at 12-months of age is scant. Some evidence suggests that higher maternal caffeine intake during pregnancy is associated with a higher risk of delivering low birth weight infants (Chen et al. 2014; Peacock et al. 2018; Rhee et al. 2015) and with pregnancy loss (Chen et al. 2016; Li et al. 2015). Furthermore, low to moderate alcohol use (1–4 glasses of alcohol per week) during pregnancy has been documented to have harmful effects on infant development (Holmgren 2009; Muggli et al. 2017), while smoking during pregnancy is associated with increased health risks to the mother and fetus/infant (Cnattingius 2004).[1] However, a recent article published by an Australian study (n = 1331) revealed that low level alcohol use by mothers (or their partners) was not associated with impaired cognitive ability in infants at 12-months of age (McCormack et al. 2018). Furthermore, no association between low-level substance use (caffeine, alcohol and tobacco) during pregnancy and maternal bonding at 8-weeks postnatal was found in a sample of 372 mother–child dyads (Rossen et al. 2016). Given the use of these substances often co-occur (Hutchinson et al. 2013; Treur et al. 2016), and have the potential to dampen the affective connection between a mother and her infant, measurement of the association with maternal bonding and EA at 12 months is

[1] The World Health Organization (WHO) recommends pregnant women with high daily caffeine intake (more than 300 mg per day) to lower their caffeine intake during pregnancy (World Health Organization 2016). WHO also recommends that all pregnant women should be advised of the potential health risks to themselves and their babies posed by alcohol and drug use. Health-care providers are advised to routinely offer advice and psychosocial interventions for tobacco cessation for all pregnant women who are either current tobacco users or recent tobacco quitters (strong recommendation based on moderate quality evidence).

warranted, especially in light of the lack of research currently available.

To summarise, given the importance of the mother–infant bond and EA in determining infant health and development, understanding the factors that promote (or negatively impact) the development of a healthy relationship is critical. Theory suggests that the early maternal–infant bond, maternal mental health, and substance use and might be key targets, yet surprisingly little longitudinal research supports these claims within general community samples. The purpose of this study was thus to prospectively examine the extent to which early bonding, maternal mental health and substance use (8-weeks postnatal) predicted mother–infant bonding and EA at infant age 12-months. Based on prior research (Alhusen 2008; Cannella 2005; Yarcheski et al. 2009), a number of demographic and postnatal variables were selected as potential covariates. These variables included: maternal age (years); maternal country of birth; employment status; socioeconomic status; whether or not other children were present in the family; infant birth weight (kg), and; infant gestation (weeks). Stronger postnatal bonding was hypothesised to predict higher levels of bonding and EA at 12-months of age, and; increased levels of maternal substance use and mental health was hypothesised to predict poorer mother–infant bonding and EA at 12-months of age.

Method

Data were obtained from the Bumps, Babies, and Beyond (Triple B) study, a longitudinal study conducted by the National Drug and Alcohol Research Centre (NDARC) at the University of New South Wales (UNSW) in Sydney, and by the National Drug Research Institute (NDRI) at Curtin University, Perth, in collaboration with Deakin University, and the Universities of Sydney and Queensland. The study examined the impact of parental substance use on infant development and family functioning (Hutchinson et al. 2018). A total of 1623 women were recruited during pregnancy between 2009 and 2013. Ethics approval was obtained from the Human Research Ethics Committees of each participating hospital, the Area Health Services in which the hospitals were located and UNSW.

Procedure

Pregnant women were approached by trained researchers in waiting rooms at general antenatal clinics and specialist drug and alcohol antenatal clinics attached to Royal Prince Alfred Hospital (RPA), the Royal Hospital for Women (RHW) and Liverpool Hospital in the New South Wales (NSW) Area Health Service. Women gave informed consent and were followed up prospectively, with maternal data for the present study being collected during pregnancy (trimester three), and at 8-weeks and 12-months postpartum.

Participants

Participants comprised a subsample of 308 mother–infant dyads recruited between October 2008–August 2012, for whom observational EA data were available and coded. Eligibility criteria were: being pregnant (conception to 40-weeks gestation); aged 16-years or more; no major medical complications; residence in NSW; intention of mother or both parents to be the primary caregiver/s; being mentally able to complete study measures; and possessing sufficient English literacy. Comparisons between the current sample and the completed study sample [blinded] show that women were similar in their: mean age ($t = 1.11$, $p = .27$); country of birth ($N = 1{,}575$; χ^2 ($df = 6$), 11.36, $p = .08$); socioeconomic status (SEIFA; $N = 1{,}272$; χ^2 ($df = 9$), 8.72, $p = .46$); marital status ($N = 1{,}569$; χ^2 ($df = 4$), 7.75, $p = .10$), and; first time pregnancy status; ($N = 1{,}572$; χ^2 ($df = 1$), 2.92, $p = .09$). Women in the sub-study were less likely to report Aboriginal and Torres Strait Islander background ($N = 1{,}575$; χ^2 ($df = 2$), 6.64, $p < .05$) and more likely to be employed full-time ($N = 1{,}575$; χ^2 ($df = 6$), 30.09, $p < .001$). Comparing the sample to the Australian population of women giving birth in 2012 (Hilder et al. 2014) we found similarities in: maternal age; nulliparous; gestational age, and; infant weight.[2] Factors that appeared different to the population (Hilder et al. 2014) include: Indigenous background; country of birth, and; tobacco use.[3]

Measures

Demographic Information and Birth Outcomes

Demographic variables collected via structured interview in trimester three (27 weeks-birth) included: age; marital status; employment status; SEIFA[4]; highest level of education;

[2] Average maternal age in this study was 32.5 years (the average in the population was 30 years), 40.3% of women in this study were nulliparous (42.4% in the population); the average gestational age in our study was 39.4 weeks (the population average was 38.8 weeks); and the average weight of babies in this study was 3.47 kgs (the population average was 3.37 kgs).

[3] 1% of women in this study were from an Indigenous background, while 4% of women are indigenous in the general population; 58.4% of women in this study were born in Australia, while 68.8% of women giving birth in the population are Australian-born; 6% of women smoked tobacco in this study, which was half the rate of women smoking during pregnancy in the population.

[4] The ABS Socioeconomic Indexes for Areas (SEIFA) provides a measure of relative advantage and disadvantage (Pink 2008). The present study used SEIFA deciles of relative advantage and disadvantage as an indicator of family SES (Australian Bureau of Statis-

country of birth; Aboriginal or Torres Strait Islander status; living arrangements; desire to be pregnant and whether or the mother was nulliparous (i.e., their first pregnancy). Birth weight (kg) and gestation (weeks) was collected via interview and from child health records at 8-weeks postpartum.

Bonding to the Infant

The Maternal Postnatal Attachment Scale (MPAS; 19-items) (Condon and Corkindale 1998) was used to measure a mother's reported feelings about her infant at 8-weeks and 12-months postnatal. The scale has demonstrated reliability and construct validity (Condon and Corkindale 1998). Cronbach alpha for the total scale in this sample was 0.65 at 8-weeks and 0.71 at 12-months, slightly lower than the original reported Cronbach alpha of 0.78 (Condon and Corkindale 1998).

Emotional Availability

The Emotional Availability (EA) Scales, 4th-edition (Biringen 2008), were used to code the quality of dyadic interactions during a 20-min free play observational session recorded at 12-months of age. The reliability and stability of the EA Scales across contexts and over time is well documented (Bornstein et al. 2008). Construct validity has also been established (Biringen 2000). Research staff were trained in coding of the video play sessions using the EA Scales. Inter-rater reliability (or concordance) between coders on a random sample of 53 mothers was high (r = .82).

Mental Health

The short-form version of the Depression Anxiety Stress Scales (DASS-21) (Lovibond 1995) assessed symptoms of maternal anxiety and stress while the Edinburgh Postnatal Depression Scales (EPDS; 21-item screening measure) assessed depressive symptoms at 8-weeks. Cronbach alpha for the DASS-21 and the EPDS was 0.80 and 0.82 respectively at 8-weeks.

Substance Use

Self-reported frequency and typical quantity of maternal caffeine,[5] alcohol and tobacco use was collected at 8-weeks. Frequency and quantity of caffeine scores were combined into a continuous scale, milligrams (mg) per week. Frequency and quantity of alcohol scores were combined into a continuous scale, standard drinks (SD) per week. Tobacco was reported as total number of cigarettes per day.

Statistical Analysis

All data were analysed with the Statistical Package for Social Sciences (SPSS) 22 (IBM Corp. 2013). Descriptive statistics for mother–infant bonding, mental health and substance use postnatal (8-weeks) were examined. A series of bivariate analyses were conducted for each factor with bonding and EA at 12-months. Two separate multiple linear regression analyses were conducted using bonding, maternal mental health and substance use as continuous independent variables (8-weeks), and bonding and EA as the dependent variables (12-months), controlling for socio-demographic and postnatal variables. To test the role of early bonding, linear regression models were conducted after removing bonding at 8-weeks. Post-hoc linear regression models were conducted with the mother's *desire to become pregnant* included in the analysis to explore possible associations between tobacco use and EA at 12-months. Reliability analyses were conducted using the Intra-Class Coefficient (ICC).

Results

Descriptive Results

Demographic and Obstetric Characteristics

Table 1 summarises sample demographics and obstetric characteristics of the sample. Summary data on pregnancy statistics, labour and postnatal complications, and women's health-related concerns are detailed in Supplementary Table S1.

Study Measures

Summary statistics for the MPAS, DASS-21, EPDS and EA Scales are shown in Table 2.

Footnote 4 (continued)

tics 2008). These deciles were collapsed into the following categories for the present analyses: low SES (deciles 1–3); medium SES (deciles 4–7); and high SES (deciles 8–10). Using the SEIFA Index of Relative Socioeconomic Advantage and Disadvantage (IRSAD) score, the mean IRSAD score in the present sample was 1052.4 (SD 56.6).

[5] Caffeine use included: black tea; coffee (instant, brewed, espresso); energy drinks, and; soda drinks.

Table 1 Sample demographic and obstetric characteristics

Characteristic	n	Mean (*SD*)
Pregnancy (third trimester)		
Mean age (years)	308	32.51 (*4.73*)*
	n	%
Marital status		
Married or de facto[a]	304	99.00
No partner or not living with partner	3	1.00
Employment status		
Full time	160	51.90
Part time/casual	63	20.50
Unemployed/student/home duties	85	27.60
SEIFA		
Low	10	3.20
Medium	85	27.60
High	213	69.20
Highest level of education		
Did not complete year 10	2	0.60
Completed year 10	12	3.90
Completed year 12	31	10.10
Completed TAFE/technical	43	14.00
Completed university/college	220	71.40
Country of birth		
Australia	180	58.40
Other english speaking country (OESC)	67	21.80
Non english speaking background (NESB)	61	19.80
Indigenous		
Aboriginal and/or Torres Strait Islander	3	1.00
Non aboriginal Torres Strait Islander	305	99.00
Living arrangement		
Renting	144	46.80
Privately own	150	48.70
Staying with friends/family	10	3.20
Other	4	1.30
Pregnancy		
Wanted to become pregnant	256	83.10
Didn't want to become pregnant	12	3.90
Hadn't thought about becoming pregnant	26	8.40
Other	14	4.50
First pregnancy		
Yes	124	40.40
No	183	59.60
Postnatal infant characteristics (8-weeks)	n	Mean (*SD*)
Infant's birth weight (kg)	303	3.47 (*0.51*)
Gestation at birth (weeks)	303	39.40 (*1.64*)

Please note: Numbers varied due to missing data on that particular variable

[a]A de facto relationship is defined in Sect. 4AA of the Australian Family Law Act (1975) as a couple living together on a genuine domestic basis

SD standard deviation, *SES* socioeconomic status, *SEIFA* Socio-Economic Indexes for Areas, *TAFE* tertiary and further education, *OESC* other english speaking country, *NESB* non-english speaking background

Table 2 Summary statistics of maternal bonding, mental health and EA measures postnatal

	n	M	SD	Range	
				Minimum	Maximum
Bonding (MPAS)					
8-Week	296	84.67	6.21	54.68	95.00
12-Months	297	84.47	6.00	64.00	95.00
Stress (DASS-21) 8-weeks	302	6.78	5.87	0.00	24.00
Anxiety (DASS-21) 8-weeks	301	1.53	3.17	0.00	32.00
Depression (EPDS) 8-weeks	299	4.02	3.60	0.00	19.00
Emotional availability (EA) subscales 12-months					
Adult sensitivity	308	25.77	2.97	14.00	29.00
Adult structuring	308	24.80	3.36	9.00	29.00
Adult non-intrusiveness	308	25.59	3.04	12.00	29.00
Adult non-hostility	308	28.47	1.29	19.00	29.00
Child responsiveness	308	25.36	2.99	14.00	29.00
Child involvement	308	22.07	4.08	10.00	29.00
EA total score 12-months	308	85.49	9.81	40.00	100.00

Please note: Numbers may vary due to missing data

MPAS Maternal Postnatal Attachment Scale, *DASS-21* Depression Anxiety Stress Scale short form version, *EPDS* Edinburgh Postnatal Depression Scale

Table 3 Summary statistics of substance use (caffeine, alcohol and tobacco) at 8-weeks postnatal

	Number of respondents	Number using substance	Quantity consumed[a]		Range	
	N	N (%)	Mean	SD	Min	Max
Caffeine[b]	302	267 (88.41)	503.07	520.72	0.00	3360.00
Alcohol[c]	302	196 (64.90)	1.92	3.22	0.00	21.00
Tobacco[d]	302	18 (5.96)	10.00	11.29	1.00	40.00

[a]Women who consumed the relevant substance only

[b]Milligrams per week

[c]Standard drinks per week

[d]Cigarettes per day

Caffeine, Alcohol and Tobacco Use

Table 3 shows the summary statistics for substance use at 8-weeks postpartum. On average, women in the study who reported caffeine use drank 503 mg of caffeine per week; approximately 5 cups of brewed coffee or 10 cups of black tea.[6] Mean alcohol intake by women was 1.9 standard drinks per week (just over one glass of wine or one bottle of full strength beer[7]), while cigarette smoking averaged 10 cigarettes per day (among smokers).

Correlation Analysis

Pearson correlation coefficients were calculated between the predictor (maternal bonding; caffeine, alcohol and tobacco consumption; symptoms of stress, anxiety and depression at 8-weeks postpartum) and outcome variables (bonding and EA at 12-months postpartum) and are summarised in Table 4.

Regression Analysis

The results of the linear regression analyses assessing bonding and EA can be found in Table 5. Each regression model adjusted for demographic and postnatal covariates, which included: age (years); country of birth; employment status; SEIFA; whether or not other children; infant's birth weight (kg) and week's gestation. Tobacco use at 8-weeks was coded as a binary variable (yes/no).

Bonding

Bonding at 8-weeks predicted bonding at 12-months ($t = 11.74$, $p < .001$), after controlling for demographic and postnatal variables. When early bonding was removed, a significant negative relationship between bonding and symptoms of stress ($t = -2.79$, $p < 0.01$) and depression ($t = -2.75$, $p < 0.01$) was found (see Supplementary Table S2).

[6] Please note that actual caffeine content of a cup of coffee or tea can vary due to factors such as origin, processing and preparation method, including brewing time.

[7] Please note that these examples are a guide only.

Table 4 Correlation between maternal bonding at 8-weeks and 12-months postnatal and EA, substance use (caffeine, alcohol and tobacco) and mental health (stress, anxiety and depression) scores (N = 308)

Measure	1	2	3	4	5	6	7	8	9
1. Bonding (MPAS) 8-weeks	1								
2. Caffeine 8-weeks	−.03	1							
3. Alcohol 8-weeks	−.07	.25**	1						
4. Tobacco 8-weeks	.06	.13*	.05	1					
5. Stress (DASS-21) 8-weeks	−.41**	.02	.09	.13*	1				
6. Anxiety (DASS-21) 8-weeks	−.13*	−.11	−.04	.07	.42**	1			
7. Depression (EPDS) 8-weeks	−.37**	.00	−.04	.07	.63**	.48**	1		
8. Bonding (MPAS) 12-months	.64**	−.05	−.02	−.04	−.34**	−.13*	−.32**	1	
9. EA 12-months	.04	.04	.12*	−.15*	−.07	−.14*	−.12*	−.06	1

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

MPAS Maternal Postnatal Attachment Scale, *DASS-21* Depression Anxiety Stress Scale short form version, *EPDS* Edinburgh Postnatal Depression Scale, *EA* emotional availability

Emotional Availability

Tobacco use predicted poorer EA at 12-months ($t = -2.50$, $p < .01$), after controlling for demographic and postnatal variables. Given the low number of smokers in the current sample, a series of post hoc comparisons were run between smokers and non-smokers. Smokers were: more likely to be younger ($t(300) = 1.27$, $p = .21$); less educated ($N = 302$; χ^2 ($df = 4$) $= 50.60$, $p < .001$); had lower SEIFA scores ($t(300) = 2.87$, $p = .77$); less likely to be employed full time ($N = 302$; χ^2 ($df = 5$) $= 28.67$, $p < .001$) and less likely to have wanted to become pregnant ($N = 302$; χ^2 ($df = 3$) $= 29.72$, $p < .001$). No difference was found between smokers and non-smokers in their country of birth ($N = 302$; χ^2 ($df = 2$) $= 1.29$, $p = .52$). To explore the association between tobacco use and EA at 12-months, *desire to be pregnant* was included in the model (see Supplementary Table S3). Significant inverse main effects were found with EA at 12-months for women who did not want to be pregnant ($t = -10.22$, $p < 0.01$) and for women who had not thought about becoming pregnant ($t = -4.34$, $p < 0.01$; see Supplementary Table S3). Tobacco use was no longer significant in this model. No interaction effects were found between tobacco use and desire to become pregnant on EA at 12-months postnatal.

Discussion

This study sought to address important gaps in knowledge on the development of mother–infant relationship quality in the first year of life by examining a range of factors theorised to be associated with maternal bonding and EA in infancy. The study also adds to the existing literature by using self-report and observational data together in a longitudinal design. Results indicated that symptoms of stress and depression were associated with maternal bonding at 12-months, but these effects did not persist after adjustment for maternal bonding at 8-weeks. Tobacco use at 8-weeks was a significant predictor of poorer EA at 12-months, but the small effect did not persist when a mother's desire to be pregnant was included in the analysis. Importantly, the results underscore the importance of early bonding in promoting the emotional connection between a mother and her infant. Health promotion messages to enhance mother–infant relationship quality might be specifically targeted to mothers who report poor bonding postpartum, tobacco use, low pregnancy desire or an unplanned pregnancy, and elevated symptoms of depression and stress (markers of emotional dysregulation).

Maternal Bonding

Early bonding has previously been found to be the major predictor of bonding at 12-months using the MIBQ in 50 depressed and 29 non-depressed mothers (O'Higgins et al. 2013). The present research extends on O'Higgins et al. (2013) by using a larger, non-clinical, general community sample, and including a range of other potential predictors in the regression models. This study also sought to understand whether self-report and observational methods provide unique or complementary information about mother–infant relationship quality at 12-months. Contrary to expectations, self-reported bonding at 8-weeks predicted bonding but not EA at 12-months. One possible reason for this discrepancy may be measurement error, consistent with the view that self-report and observational assessments do not necessarily yield comparable outcomes (Bornstein 2002; Vliegen et al. 2009). Alternatively, it is possible that the relationship as measured by the self-reported bond might be qualitatively different to the relationship assessed by the EA Scales. A mother's perceptions of her felt affective bond may not be captured by observational tools which typically assess behaviour (Condon 2012). Further research

Table 5 Regression analyses predicting mother-infant bonding and EA at 12-months (N = 308)

	Maternal Postnatal Attachment Scale (12-months)				Emotional Availability Scale (12-months)			
	B	*β*	*t*	*p*	B	*β*	*t*	*P*
Demographic variables								
Age	0.12	0.10	1.86	0.06	0.34	0.17	2.59	0.01**
Country of birth								
Australia (reference)								
OESC	0.35	0.02	0.49	0.62	1.54	0.07	1.07	0.29
NESB	0.04	0.00	0.06	0.96	1.28	0.05	0.84	0.40
Employment status								
Full-time (reference)								
Part-time	−0.53	−0.04	−0.70	0.48	1.75	0.07	1.14	0.26
Other[a]	−1.48	−0.11	−2.06	0.04*	1.38	0.06	0.94	0.35
SES (SEIFA)								
Low (reference)								
Medium	−1.82	−0.13	−1.10	0.27	6.39	0.29	1.86	0.06
High	−2.83	−0.22	−1.74	0.08	7.58	0.35	2.25	0.03*
Other children (0 = No, 1 = Yes)	−0.51	−0.04	−0.72	0.47	−2.68	−0.13	−1.86	0.06
Postnatal variables								
Infant's birth weight	−0.38	−0.03	−0.58	0.56	0.13	0.01	0.10	0.92
Weeks gestation	0.08	0.02	0.41	0.68	0.02	0.00	0.04	0.97
8-Weeks predictors								
Postnatal bonding	0.61	0.63	11.74	0.00***	0.10	0.06	0.92	0.36
Caffeine	0.00	−0.03	−0.55	0.58	0.00	0.02	0.34	0.73
Alcohol	0.04	0.02	0.49	0.62	0.18	0.06	0.98	0.33
Tobacco	−1.30	−0.05	−1.09	0.28	−6.16	−0.15	−2.50	0.01**
Stress	−0.07	−0.06	−1.00	0.32	0.08	0.05	0.56	0.57
Anxiety	0.01	0.01	0.13	0.89	−0.32	−0.10	−1.53	0.13
Depression	0.01	0.00	0.06	0.95	−0.14	−0.05	−0.63	0.53
	$R^2 = 0.45\left(R^2_{adj} = 0.42\right)$				$R^2 = 0.12\left(R^2_{adj} = 0.07\right)$			
	$F = 12.82$				$F = 2.21$			
	$p < .001$				$p < .001$			

OESC other english speaking country, *NESB* non-english speaking background, *SES* socioeconomic status, *SEIFA* Socio-Economic Indexes for Areas

[a]Other = Unemployed/student/home duties

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

using a multi-method approach is warranted to clarify this discrepant result.

Mental Health

The role of maternal mental health (including symptoms of depression, anxiety and stress) at 8-weeks postnatal was examined as a predictor of maternal bonding and EA at 12-months of age. Symptoms of stress and depression were associated with bonding at 12-months; however, this effect did not remain after adjustment for bonding at 8-weeks. Our results are consistent with past work which found that early bonding, rather than symptoms of early depression, was the major predictor of later bonding at 12-months of age (O'Higgins et al. 2013). The current findings support and extend the work of O'Higgins et al. (2013) by utilising a larger sample of mother–child dyads (n = 308), including other theorised predictors of bonding (e.g., substance use), and controlling for a range of potential background covariates. Taken together, our results suggest that early bonding is the most critical of the factors examined in predicting the relationship between a mother and her infant in the postnatal period. This further underscores the importance of fostering a healthy mother–infant bond as part of postnatal care.

Substance Use

Tobacco use at 8-weeks was a significant predictor of poorer EA in this study, albeit the effect was small (r = − .15). Little is known about how tobacco use might impact on the mother–infant relationship. It is possible that mothers who smoke are also characterised by other risk factors that together, impact negatively on EA (e.g., low educational attainment or SEIFA). Consistent with this explanation, mothers who smoked in the study reported being younger, having lower educational attainment and socio-economic status, and they were also less likely to be employed full-time. We did control for these covariates in the regression models, although residual confounding cannot be ruled out. Another plausible explanation for this relationship is that tobacco use is a proxy for emotional dysregulation. Smoking has been linked to less optimal emotion regulation capacity and may represent a form of self-medication or avoidance of emotional awareness (Koole 2009; Sloan et al. 2017). Therefore, tobacco use may not completely explain this result, rather, smoking may indicate less optimal capacity to affectively connect with, and co-regulate, an infant's emotional states (Field 1994).

When post hoc analyses were conducted with a women's *desire to be pregnant* included, tobacco use was no longer a significant negative predictor of EA at 12-months; but *desire to be pregnant* was significant, both for those women who did not want to be pregnant and for those women who had not thought about becoming pregnant. Therefore, another potential pathway to explain why women who smoke in the early postnatal period report lower emotional availability to their children is their *desire to be pregnant*. A meta-analysis of maternal–fetal attachment found no significant relationship between planned pregnancy and attachment during pregnancy in 10 derived studies (Yarcheski et al. 2009), but they did not examine other aspects of the mother–infant relationship, such as bonding or EA in the postnatal period. Although tobacco use and a lack of desire to be pregnant predicted poorer EA in this study, the effect sizes were small. Further research would help understand the nature of the relationship between tobacco use and mother–infant relationship quality.

Strengths and Limitations

This study adds to the extant literature by (1) using prospective, longitudinal data to examine early postpartum predictors of maternal bonding and EA at 12-months post-birth, (2) in a general community sample, (3) including both self-report and observational assessments of the mother–child relationship, and (4) controlling for a range of key socio-demographic and postnatal variables. Although the reliability and validity of the EA scales have been established (Biringen 2000; Bornstein et al. 2008; Ziv et al. 2000), observational measurements are prone to biases, such as the "halo effect", where a coder will code all dimensions similarly high or low (Biringen et al. 2014). Nonetheless, inter-rater coding of a random set of EA play sessions (n = 53) resulted in an inter-rater coefficient of 0.82, suggesting that subjective bias is likely to have been minimal. The sample also represents a somewhat advantaged group of predominantly Anglo-Saxon. Nevertheless, comparisons with the Australian population of women giving birth in 2012 was similar on a range of demographic and birth factors (Hilder et al. 2014).

Conclusion

In this study, 308 Australian mothers and infants were assessed longitudinally over the first year of life to prospectively examine predictors of maternal bonding and maternal–infant EA, controlling for a range of sociodemographic and postnatal variables. The study found that symptoms of stress and depression were associated with bonding at 12-months, but these effects did not persist after adjustment for bonding at 8-weeks. Tobacco use was also a weak predictor of poorer EA at 12-months. A number of possible explanations for this finding exist, but future research is needed to elucidate the relationship between tobacco use and a mother's emotional availability to her infant. Further mixed-method research utilising both self-report and observational methods to assess the mother–infant relationship is also recommended. Importantly, the results suggest that early bonding is a more robust indicator of later bonding at 12-months than a mother's mental health or substance use. This work has direct clinical and public health implications for supporting the establishment of a healthy mother–infant bond early in the postpartum period.

Acknowledgements The authors wish to acknowledge the investigators not listed as authors, the Bumps, Babies and Beyond (Triple B) research staff who collected the data, the hospitals/antenatal clinics, and the participants. Funding was provided by the Australian National Health and Medical Research Council (Grant Number GNT630517), a NHMRC Principal Research Fellowship Award (Grant Number APP1045318), a UNSW Vice-Chancellor's Research Fellowship Award, an Australian Research Council Principal Fellowship (Grant Number DORA: LP130101459), and a NHMRC Practitioner Fellowship (Grant Number 1021480).

Compliance with Ethical Standards

Conflicts of interest We do not have any conflicts of interest affecting the conduct or reporting of this research.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the insti-

tutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

Ainsworth, M. D. S., & Bell, S. M. (1972). *Mother-infant interaction and the development of competence*. New York: Academic Press.

Alhusen, J. L. (2008). A literature update on maternal-fetal attachment. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 37*(3), 315–328.

Altenhofen, S., Clyman, R., Little, C., Baker, M., & Biringen, Z. (2013). Attachment security in three-year-olds who entered substitute care in infancy. *Infant Mental Health Journal, 34*(5), 435–445. https://doi.org/10.1002/imhj.21401.

Altenhofen, S., Sutherland, K., & Biringen, Z. (2010). Families experiencing divorce: Age at onset of overnight stays, conflict, and emotional availability as predictors of child attachment. *Journal of Divorce & Remarriage, 51*(3), 141–156. https://doi.org/10.1080/10502551003597782.

Aviezer, O., Sagi, A., Joels, T., & Ziv, Y. (1999). Emotional availability and attachment representations in kibbutz infants and their mothers. *Developmental Psychology, 35*(3), 811.

Aviezer, O., Sagi-Schwartz, A., & Koren-Karie, N. (2003). Ecological constraints on the formation of infant–mother attachment relations: When maternal sensitivity becomes ineffective. *Infant Behavior and Development, 26*(3), 285–299. https://doi.org/10.1016/S0163-6383(03)00032-8.

Biringen, Z. (2000). Emotional Availability: Conceptualization and Research Findings. *American Journal of Orthopsychiatry, 70*(1), 104–114. https://doi.org/10.1037/h0087711.

Biringen, Z. (2008). Emotional availability (EA) scales manual. *Unpublished manual. Boulder: Colorado State University*.

Biringen, Z., Damon, J., Grigg, W., Mone, J., Pipp-Siegel, S., Skillern, S., et al. (2005). Emotional availability: Differential predictions to infant attachment and kindergarten adjustment based on observation time and context. *Infant Mental Health Journal, 26*(4), 295–308. https://doi.org/10.1002/imhj.20054.

Biringen, Z., Derscheid, D., Vliegen, N., Closson, L., & Easterbrooks, M. A. (2014). Emotional availability (EA): Theoretical background, empirical research using the EA Scales, and clinical applications. *Developmental Review, 34*(2), 114–167. https://doi.org/10.1016/j.dr.2014.01.002.

Biringen, Z., & Easterbrooks, M. A. (2012). Emotional availability: Concept, research, and window on developmental psychopathology. *Development and Psychopathology, 24*(01), 1–8. https://doi.org/10.1017/S0954579411000617.

Bornstein, M. H. (2002). *Parenting infants. Handbook of parenting, 1,* 3–43.

Bornstein, M. H. (2014). Human Infancy… and the rest of the lifespan. *Annual Review of Psychology, 65,* 121–158. https://doi.org/10.1146/annurev-psych-120710-100359.

Bornstein, M. H., Putnick, D. L., Heslington, M., Gini, M., Suwalsky, J. T. D., Venuti, P., et al. (2008). Mother-child emotional availability in ecological perspective: Three countries, two regions, two genders. *Developmental Psychology, 44*(3), 666–680. https://doi.org/10.1037/0012-1649.44.3.666.

Cannella, B. L. (2005). Maternal–fetal attachment: An integrative review. *Journal of Advanced Nursing, 50*(1), 60–68. https://doi.org/10.1111/j.1365-2648.2004.03349.x.

Carter, A. S., Garrity-Rokous, F. E., Chazan-Cohen, R., Little, C., & Briggs-Gowan, M. J. (2001). Maternal depression and comorbidity: Predicting early parenting, attachment security, and toddler social-emotional problems and competencies. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*(1), 18–26. https://doi.org/10.1097/00004583-200101000-00012.

Chen, L.-W., Wu, Y., Neelakantan, N., Chong, M. F.-F., Pan, A., & van Dam, R. M. (2014). Maternal caffeine intake during pregnancy is associated with risk of low birth weight: A systematic review and dose-response meta-analysis. *BMC Medicine, 12*(1), 174. https://doi.org/10.1186/s12916-014-0174-6.

Chen, L. W., Wu, Y., Neelakantan, N., Chong, M. F., Pan, A., & van Dam, R. M. (2016). Maternal caffeine intake during pregnancy and risk of pregnancy loss: A categorical and dose-response meta-analysis of prospective studies. *Public Health Nutrition, 19*(7), 1233–1244. https://doi.org/10.1017/s1368980015002463.

Cnattingius, S. (2004). The epidemiology of smoking during pregnancy: Smoking prevalence, maternal characteristics, and pregnancy outcomes. *Nicotine & Tobacco Research, 6*(Suppl_2), S125–S140.

Condon, J. (2012). Assessing attachment, a work in progress: To look, to listen or both? *Journal of Reproductive and Infant Psychology, 30*(1), 1–4. https://doi.org/10.1080/02646838.2012.681966.

Condon, J. T., & Corkindale, C. J. (1998). The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. *Journal of Reproductive and Infant Psychology, 16*(1), 57–76. https://doi.org/10.1080/02646839808404558.

Davies, D. (2010). *Child development: A practitioner's guide*. New York: Guilford Press.

Easterbrooks, A. M., Biesecker, G., & Lyons-Ruth, K. (2000). Infancy predictors of emotional availability in middle childhood: The roles of attachment security and maternal depressive symptomatology. *Attachment & Human Development, 2*(2), 170–187. https://doi.org/10.1080/14616730050085545.

Espinet, S. D., Jeong, J. J., Motz, M., Racine, N., Major, D., & Pepler, D. (2013). Multimodal assessment of the mother-chid relationship in a substance-exposed sample: Divergent associations with the emotional availability scales. *Infant Mental Health Journal, 34*(6), 496–507.

Field, T. (1994). The effects of mother's physical and emotional unavailability on emotion regulation. *Monographs of the Society for Research in Child Development, 59*(2–3), 208–227.

Flykt, M., Punamäki, R. L., Belt, R., Biringen, Z., Salo, S., Posa, T., et al. (2012). Maternal representations and emotional availability among drug-abusing and nonusing mothers and their infants. *Infant Mental Health Journal, 33*(2), 123–138. https://doi.org/10.1002/imhj.21313.

Fonseca, V. R., Silva, G. A., & Otta, E. (2010). The relationship between postpartum depression and maternal emotional availability. *Cad Saude Publica, 26*(4), 738–746.

Fraser, J. G., Harris-Britt, A., Thakkallapalli, E. L., Kurtz-Costes, B., & Martin, S. (2010). Emotional availability and psychosocial correlates among mothers in substance-abuse treatment and their young infants. *Infant Mental Health Journal, 31*(1), 1–15. https://doi.org/10.1002/imhj.20239.

Hilder, L., Zhichao, Z., Parker, M., Jahan, S., & Chambers, G. M. (2014). *Australia's mothers and babies 2012. Perinatal statistics series no. 30*. Retrieved from Canberra:

Holmgren, S. (2009). *Low dose alcohol exposure during pregnancy-does it harm?* Statens Folkhälsoinstitut.

Hutchinson, D., Moore, E. A., Breen, C., Burns, L., & Mattick, R. P. (2013). Alcohol use in pregnancy: Prevalence and predictors in the Longitudinal Study of Australian Children. *Drug and Alcohol Review, 32*(5), 475–482. https://doi.org/10.1111/dar.12027.

Hutchinson, D., Wilson, J., Allsop, S., Elliott, E., Najman, J., Burns, L., et al. (2018). Cohort Profile: The Triple B Pregnancy Cohort

Study: A longitudinal study of the relationship between alcohol, tobacco and other substance use during pregnancy and the health and well-being of Australian children and families. *International Journal of Epidemiology, 47*(1), 26–27m. https://doi.org/10.1093/ije/dyx126.

IBM Corp. (2013). IBM SPSS statistics for Windows, version 22.0. In: IBM Corp Armonk, New York.

Johnson, K. (2013). Maternal-infant bonding: A review of literature. *International Journal of Childbirth Education, 28,* 17–22.

Koole, S. L. (2009). The psychology of emotion regulation: An integrative review. *Cognition and Emotion, 23*(1), 4–41.

Lefkovics, E., Baji, I., & Rigó, J. (2014). Impact of maternal depression on pregnancies and on early attachment. *Infant Mental Health Journal, 35*(4), 354–365.

Li, J., Zhao, H., Song, J. M., Zhang, J., Tang, Y. L., & Xin, C. M. (2015). A meta-analysis of risk of pregnancy loss and caffeine and coffee consumption during pregnancy. *International Journal of Gynaecology and Obstetrics, 130*(2), 116–122. https://doi.org/10.1016/j.ijgo.2015.03.033.

Lovibond, P. (1995). *Manual for the depression anxiety stress scales short-form (DASS-21)*. Sydney: Sydney Psychology edition.

McCormack, C., Hutchinson, D., Burns, L., Wilson, J., Elliott, E., Allsop, S., et al. (2017). Prenatal alcohol consumption between conception and recognition of pregnancy. *Alcoholism, Clinical and Experimental Research, 41*(2), 369–378. https://doi.org/10.1111/acer.13305.

McCormack, C., Hutchinson, D., Burns, L., Youssef, G., Wilson, J., Elliott, E., et al. (2018). Maternal and partner prenatal alcohol use and infant cognitive development. *Drug and Alcohol Dependence, 185,* 330–338. https://doi.org/10.1016/j.drugalcdep.2017.12.038.

Moehler, E., Brunner, R., Wiebel, A., Reck, C., & Resch, F. (2006). Maternal depressive symptoms in the postnatal period are associated with long-term impairment of mother–child bonding. *Archives of Women's Mental Health, 9*(5), 273–278. https://doi.org/10.1007/s00737-006-0149-5.

Muggli, E., Matthews, H., Penington, A., et al. (2017). Association between prenatal alcohol exposure and craniofacial shape of children at 12 months of age. *JAMA Pediatrics, 171*(8), 771–780. https://doi.org/10.1001/jamapediatrics.2017.0778.

O'Higgins, M., Roberts, I. S., Glover, V., & Taylor, A. (2013). Mother-child bonding at 1 year; associations with symptoms of postnatal depression and bonding in the first few weeks. *Archives of Women's Mental Health, 16*(5), 381–389. https://doi.org/10.1007/s00737-013-0354-y.

Pajulo, M., Savonlahti, E., Sourander, A., Ahlqvist, S., Helenius, H., & Piha, J. (2001). An early report on the mother–baby interactive capacity of substance-abusing mothers. *Journal of Substance Abuse Treatment, 20*(2), 143–151.

Peacock, A., Hutchinson, D., Wilson, J., McCormack, C., Bruno, R., Olsson, C. A., et al. (2018). Adherence to the caffeine intake guideline during pregnancy and birth outcomes: A prospective cohort study. *Nutrients*. https://doi.org/10.3390/nu10030319.

Pink, B. (2008). *Information paper: An introduction to Socio-Economic Indexes for Areas (SEIFA) 2006*. (ABS Catalogue No. 2039.0.). Canberra, Australia: Australian Bureau of Statistics, Commonwealth of Australia.

Reck, C., Zietlow, A. L., Muller, M., & Dubber, S. (2016). Perceived parenting stress in the course of postpartum depression: The buffering effect of maternal bonding. *Archives of Women's Mental Health, 19*(3), 473–482. https://doi.org/10.1007/s00737-015-0590-4.

Rhee, J., Kim, R., Kim, Y., Tam, M., Lai, Y., Keum, N., et al. (2015). Maternal caffeine consumption during pregnancy and risk of low birth weight: A dose-response meta-analysis of observational studies. *PLoS ONE, 10*(7), e0132334. https://doi.org/10.1371/journal.pone.0132334.

Rossen, L., Hutchinson, D., Wilson, J., Burns, L., Olsson, C. A., Allsop, S., et al. (2016). Predictors of postnatal mother-infant bonding: The role of antenatal bonding, maternal substance use and mental health. *Archives of Women's Mental Health, 19*(4), 609–622. https://doi.org/10.1007/s00737-016-0602-z.

Salo, S., Kivistö, K., Korja, R., Biringen, Z., Tupola, S., Kahila, H., et al. (2009). Emotional availability, parental self-efficacy beliefs, and child development in caregiver-child relationships with buprenorphine-exposed 3-year-olds. *Parenting, 9*(3–4), 244–259. https://doi.org/10.1080/15295190902844563.

Salo, S., Politi, J., Tupola, S., Biringen, Z., Kalland, M., Halmesmäki, E., et al. (2010). Early development of opioid-exposed infants born to mothers in buprenorphine-replacement therapy. *Journal of Reproductive and Infant Psychology, 28*(2), 161–179. https://doi.org/10.1080/02646830903219109.

Sameroff, A. J., & Fiese, B. H. (2000). Transactional regulation: The developmental ecology of early intervention. *Handbook of Early Childhood Intervention, 2,* 135–159.

Saunders, H., Kraus, A., Barone, L., & Biringen, Z. (2015). Emotional availability: Theory, research, and intervention. *Frontiers in Psychology, 6,* 1069.

Sloan, E., Hall, K., Moulding, R., Bryce, S., Mildred, H., & Staiger, P. K. (2017). Emotion regulation as a transdiagnostic treatment construct across anxiety, depression, substance, eating and borderline personality disorders: A systematic review. *Clinical Psychology Review, 57,* 141–163.

Swanson, K., Beckwith, L., & Howard, J. (2000). Intrusive caregiving and quality of attachment in prenatally drug- exposed toddlers and their primary caregivers. *Attachment & Human Development, 2*(2), 130–148. https://doi.org/10.1080/14616730050085527.

Thompson, R. A. (2001). Childhood anxiety disorders from the perspective of emotion regulation. *The Developmental Psychopathology of Anxiety*, 160–182.

Tietz, A., Zietlow, A. L., & Reck, C. (2014). Maternal bonding in mothers with postpartum anxiety disorder: The crucial role of subclinical depressive symptoms and maternal avoidance behaviour. *Arch Womens Ment Health, 17*(5), 433–442. https://doi.org/10.1007/s00737-014-0423-x.

Timmer, S. G., Ho, L. K., Urquiza, A. J., Zebell, N. M., Fernandez, Y. G. E., & Boys, D. (2011). The effectiveness of parent-child interaction therapy with depressive mothers: The changing relationship as the agent of individual change. *Child Psychiatry and Human Development, 42*(4), 406–423. https://doi.org/10.1007/s10578-011-0226-5.

Trapolini, T., Ungerer, J. A., & McMahon, C. A. (2008). Maternal depression: Relations with maternal caregiving representations and emotional availability during the preschool years. *Attachment & Human Development, 10*(1), 73–90. https://doi.org/10.1080/14616730801900712.

Treur, J. L., Taylor, A. E., Ware, J. J., McMahon, G., Hottenga, J. J., Baselmans, B. M., et al. (2016). Associations between smoking and caffeine consumption in two European cohorts. *Addiction, 111*(6), 1059–1068.

Vliegen, N., Luyten, P., & Biringen, Z. (2009). A multimethod perspective on emotional availability in the postpartum period. *Parenting, 9*(3–4), 228–243. https://doi.org/10.1080/15295190902844514.

World Health Organization. (2004). *Neuroscience of psychoactive substance use and dependence*. Geneva: World Health Organization.

World Health Organization. (2016). *WHO recommendations on antenatal care for a positive pregnancy experience*. Geneva: World Health Organization.

Yarcheski, A., Mahon, N. E., Yarcheski, T. J., Hanks, M. M., & Cannella, B. L. (2009). A meta-analytic study of predictors of maternal-fetal attachment. *International Journal of Nursing Studies, 46*(5), 708–715.

Zelkowitz, P., Papageorgiou, A., Bardin, C., & Wang, T. (2009). Persistent maternal anxiety affects the interaction between mothers and their very low birthweight children at 24 months. *Early Human Development, 85*(1), 51–58. https://doi.org/10.1016/j.earlhumdev.2008.06.010.

Ziv, Y., Aviezer, O., Gini, M., Sagi, A., & Karie, N. K. (2000). Emotional availability in the mother infant dyad as related to the quality of infant mother attachment relationship. *Attachment & Human Development, 2*(2), 149–169. https://doi.org/10.1080/14616730050085536.