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TITLE: Fathers' observed responsiveness towards their 12 month old infants: An Exploratory Investigation of Associations with Paternal Low Mood and Infant Development

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CONTENTS

Abstract

Fathers in two-parent families are becoming increasingly involved in infant care, highlighting the need to understand the determinants and influence of father-infant interactions. Paternal responsiveness is a core component of positive father-infant interactions. This study investigated associations between paternal responsiveness and infant development; and paternal low mood and paternal responsiveness. Participants were a sub-sample of father-infant dyads (n=47) from a UK community cohort study: The Avon Longitudinal Study of Parents and Children. The Mellow Parenting Coding System was used to measure paternal responsiveness within a video-recorded father-infant interaction at 12 months. Infant development was assessed using the Griffiths scales at 18 months and paternal low mood was measured using the Edinburgh Post-Natal Depression Scale (EPDS) at 8 months. Linear regression analysis provided no evidence for an association between paternal responsiveness and infant development. Due to methodological limitations it is unclear whether this reflects a true null relationship. Unexpectedly, lower paternal mood (indicated by higher scores on the EPDS), was found to be associated with *greater* paternal responsiveness. For every standard deviation increase in EPDS score, fathers displayed approximately two additional responsiveness behaviours per minute in the observed interaction; this corresponds to a standardised effect size of 0.32 standard deviations. The mechanisms for this association are unclear, but possibilities are discussed. The finding requires replication within larger studies, but clinicians may wish to consider that fathers who achieve very low scores on measures of depressed mood may be at risk for low paternal responsiveness.

Keywords: ALSPAC, paternal responsiveness, low-mood, infant development

Fathers' Observed Responsiveness Towards their 12-month-old Infants: An Exploratory Investigation of Associations with Paternal Low Mood and Infant Development [1]

Infancy is a period of immense investment for parents who are required to continuously care for, comfort, and teach their dependent infants every day. The quality of parent-infant interactions and infantile experiences exerts an enduring influence on the developing child (Gerhart, 2004). Although mothers are typically the primary carers, fathers in two-parent families in the United Kingdom are becoming increasingly actively involved in co-parenting their infants (Equal Opportunities Commission, 2003; Fisher, McCulloch & Gershuny, 1999; Smith, 2006). Despite this observed shift in family roles, a wealth of research relating to the nature, determinants and importance of mother-infant interactions continues to dominate the parenting literature. While this may inform our understanding of father-infant relationships, we cannot assume that the same pathways apply. Although the gap is beginning to be addressed by researchers, there continues to be a relative lack of information on the fathers' role at this crucial developmental phase. Equally, clinicians tend to assume that fathers only influence their infants by providing support to the mother, rather than acknowledging a direct role (Barrows, 1999). However, research is beginning to demonstrate that fathers and infants can benefit from interventions to improve the quality of father-infant interactions (Bakermans-Kranenburg, Van Ijzendoorn, & Juffer, 2003; Magill-Evans, Harrison, Benzies, Gierl, & Kimak, 2007). Clinical psychologists working closely with parents of infants (within perinatal, infant, child and adolescent, or adult mental health services), have an opportunity to intervene to improve fathers' mental health, promote positive father-child interactions and optimal infant development. It is therefore important

[1] This paper has been formatted in line with the nominated journal: The Journal of Family Psychology. Instructions for authors can be found in Appendix B.

that researchers and clinicians alike understand more about the nature, determinants and consequences of father-infant interactions.

Although the bi-directional nature of father-infant interactions cannot be ignored, longitudinal transactional investigations have indicated that the direction of influence may predominantly be from parent to infant in the second year of life (Eiden, Leonard, Hoyle, & Chavez, 2009).

Paternal responsiveness has been identified as a core component of father-infant interactions, and can be defined as a father's positive verbal and non-verbal responses towards his infant. This may include sensitive or didactic behaviours, as well as expressions of positive affect (Shannon, Tamis-LeMonda, & Cabrera, 2006). Although these behaviours capture distinct aspects of paternal responsiveness, they are highly related and therefore frequently combined and referred to collectively (e.g. Shannon, et al., 2006; Shannon, Tamis-LeMonda, London, & Cabrera, 2002; Tamis-LeMonda, London, & Cabrera, 2004).

Attachment theory suggests that sensitive and responsive parenting contributes to a 'secure attachment' (emotional bond) between parent and infant (Ainsworth, et al., 1978; Bowlby, 1988). Indeed, maternal responsiveness and paternal responsiveness have both been associated with infant attachment security (Bakermans-Kranenberg, Van Ijzendoorn & Juffer; Lucassen, Tharner, Van Ijzendoorn, Bakermans-Kranenburg, Volling, Verhulst, Lambregtse-Van den Berg, & Tiemeier, 2011; Van Ijzendoorn & DeWolff, 1997). A securely attached infant uses their parent as a 'safe haven' to return to in times of distress and a 'secure base' from which to confidently investigate the world; fostering social, emotional, and cognitive development as well as skills acquisition (Ainsworth, et al 1978; Bowlby, 1988). Attachment theory has since been extended to describe the complimentary roles that mothers and fathers may play as attachment figures. Grossman, Grossman, and Zimmerman (2002) emphasise the fathers' role in providing security through sensitive and challenging responsiveness when

the child's exploratory system is aroused; thereby complementing the 'safe haven' role commonly employed by the mother. In support of this, Grossman et al. (2002) found that fathers' sensitive and challenging responsiveness during play predicted later behavioural and psychological outcomes for children over and above father-infant attachment security.

Advances in neurological research suggest that timely parental stimulation that supports the infants' current activity strengthens brain circuits and thus developmental potential (Gerhart, 2004; Schore, 2005). Studies of mothers and infants have found that positive responses are a vital stimulus. For example, maternal smiling stimulates the release of beta-endorphin and dopamine which travels to the Orbito-frontal (social) part of the infant brain and causes it to develop (Schore, 2005).

It is well established that maternal responsiveness is associated with later infant development (Pearson, Heron, Melotti, Joinson, Ramchandani & Evans, 2011); language abilities (Tamis-LeMonda & Bornstein, 2002); and cognitive development (Evans, Ricciuti, Hope, Schoon, Bradley, Corwyn, & Hazan, 2010). However, research is yet to consistently demonstrate that *paternal* responsiveness impacts on infant development.

Cross-sectional studies of paternal responsiveness conducted in the United States of America have found evidence of a concurrent association with global infant development and a range of specific abilities including social skills, problem solving abilities, and communication skills in infants between the ages of 8 and 36 months (Connor, Knight & Cross, 1997; Easterbrooks and Golding, 1984; Kelley et al 1998, Shannon et al., 2002; Shannon et al., 2006; Tamis-LeMonda, et al., 2004). However, cross-sectional studies are unable to inform whether variations in paternal responsiveness might *influence* child development as it is possible that developmentally advanced infants evoke a greater degree of responsiveness from their fathers.

To date, only a handful of longitudinal studies have been published, and provide inconsistent evidence of an association between paternal responsiveness and later infant development. Tamis-LeMonda et al. (2004) found that low-income fathers demonstrating higher paternal responsiveness during play at 24 months, had toddlers with more advanced vocabulary and global development at 36 months; independently of maternal responsiveness, parent education, and prior infant development. Yet, another longitudinal study of low-income fathers found that paternal responsiveness at 8 months was only marginally positively associated with infant social and communication skills at 16-months, and confounding factors were not considered (Shannon et al., 2006). Furthermore, Magill-Evans & Harrison (1999) did not find paternal responsiveness during teaching tasks at 3 and 12 months to be associated with infant development at 18 months in a sample of pre- and full-term infants. The inconsistent results could be explained by variations in the studies including different infant ages; differential measurement of infant outcomes, paternal responsiveness and observation settings; variable sample sizes and demographic differences. A major limitation of many of the studies is that they did not control for correlates of paternal responsiveness and infant development identified in the literature, including maternal responsiveness, paternal education, extent of paternal involvement, and prior infant development (Boechler, Harrison & Magill-Evans, 2003; Pearson et al., 2001; Sarkadi, Kristiansson, Oberklaid, & Bremberg, 2008; Shannon et al., 2006; Tamis-LeMonda et al., 2004).

In order to identify fathers and infants at risk of low paternal responsiveness, it is important to understand what factors influence paternal responsiveness. Belsky (1984) suggested that a parent's psychological wellbeing is the primary factor influencing parenting. It is well established that maternal depression is associated with impaired maternal responsiveness (Field, 2010; Murray, Fiori-Cowley, Hooper & Cooper, 1996) and that this may explain the association between maternal depression and poor infant development

(Murray et al., 1996; Milgroma, Westleya & Gemmilla, 2004). A large prospective population study found that paternal depression in the post-natal period was associated with a greater likelihood of child psychopathology (Ramchandani, Stein, O'Connor, Heron, Murray & Evans, 2008). The direct impact of paternal depression on father-infant interaction may account for this association.

Fathers with depression have been found to talk less to their 3 month old infants; focus their speech on their own rather than their infants' experience; make more negative comments; and make fewer references to their infants' physiological state than fathers not experiencing depression (Sethna, Murray, & Ramchandani, 2012). Interestingly, Sethna et al. (2012) did not find a difference in the proportion of fathers' positive *affective* verbalisations towards their infants. Limitations of the study included the use of a measure of fathers' verbal responses that is yet to be validated; a lack of consideration of non-verbal responses or confounding factors. A contradictory study found no significant differences in the way depressed and non-depressed fathers interacted with their 3 to 6 month old infants (Field, Hossain, & Malphurs, 1999). Compared with mothers, fathers may be more able to compensate for low mood due to spending relatively less time with their infants (Hossain, Field, Malphurs, & DelValle, 1995).

It has been argued that clinical psychologists' interests should be broader than those extremes of mood that qualify for diagnoses (Green, 1998). Indeed, clinicians are often working with distressed parents, some of which meet diagnostic criteria for depression, while others may not. Fathers who are not clinically depressed span a continuum from the ecstatic to the unhappy, which might have corresponding implications for their interactions with their infants. Indeed, subclinical levels of low mood in a low risk sample of well-functioning non-depressed parents was associated with mothers' and fathers' interactions with their infants (McElwain and Volling, 1999). Furthermore, an early study of middle-class families, found

that fathers who experienced low mood for over eight days sometime after the birth of their infant talked to their 4 month old infants less and engaged in less physical proximity and physical contact (Zaslow, Pederson, Cain, Suwalsky & Kramer, 1985).

Possible explanations for why paternal low mood might result in reduced paternal responsiveness include a reduction in 'emotional energy' for positive interaction (Goldberg et al., 2002). Furthermore, those with depression are more internally than externally focussed (Mor & Winquist, 2002), lack motivation, and engage in 'positivity suppression' (Jacob & Johnson, 2001). This suggests that the more a father struggles with low mood, the less responsive he will be towards his infant and this pattern of relating could become maintained over time.

Alternatively, depression may affect a fathers' ability to mentalise. Mentalisation has been defined as the psychological ability to hypothesise about the mental states (including thoughts, feelings, desires, beliefs and intentions) of ourselves and others (Fonagy et al., 1991; Target & Fonagy, 1996). Mentalising function is linked to affect regulation; intense high emotional arousal or detached low emotional arousal leads to a decline in mentalising ability (Bateman & Fonagy, 2010). A parents' 'reflective function' is their ability to mentalise about their infants' mind by recognising and interpreting their cues (Suchman, Pajulo, Kalland, DeCoste, & Mayes, 2012), which may aid contingent responsiveness. Therefore, if a father is depressed or experiencing significant low mood, his reflective function may become impaired, resulting in less sensitive responsiveness.

Psychological models of distress suggest that low mood develops in the context of relationships, life events and experiences. As such, it is important to determine if any relationship between paternal low mood and paternal responsiveness can be explained by other factors including the quality of the parental relationship, characteristics of the infant (e.g. temperament, birth order), maternal low mood, lack of paternal resources (such as

educational level), or paternal involvement; all of which have been related to the quality of father-infant interactions in the developing literature (Cox, Owen, Lewis, & Henderson, 1989; Lovas, 2005; Goldberg et al., 2002; Easterbrooks & Goldberg, 1984; Goodman, 2008; Shannon et al., 2006).

Summary

While there appears to be evidence for a contemporaneous association between paternal responsiveness and infant development, longitudinal studies have produced inconsistent findings. Most of the research has utilised high risk samples such as families with low social-economic status or premature infants, and all of the studies were completed in the USA or Canada. As such, the relationship between paternal responsiveness and infant development in UK community samples is currently unknown. Further investigation using longitudinal studies in the UK that control for potentially confounding factors is required to explore if paternal responsiveness is associated with later infant development.

Paternal low mood may be an important determinant of paternal responsiveness, but studies investigating this are rare. While two studies found evidence of a negative association between paternal low mood and paternal responsiveness (Sethna et al., 2012; Zaslow et al., 1985), another did not (Field, et al., 1999); suggesting further investigation is warranted. Future research should use validated measures of paternal responsiveness and would benefit from controlling for possible confounding factors.

The current research

The current research aimed to address some of the gaps in the literature by using a longitudinal design to investigate the relationship between i) paternal responsiveness and

later infant development, and ii) paternal low mood and paternal responsiveness within a UK community sample.

i) The association between observed paternal responsiveness at 12 months and infant development at 18 months. Potentially confounding variables including the prior developmental level of the infant at 6 months, paternal educational attainment and paternal involvement were considered, allowing exploration of whether any association between paternal responsiveness and infant development could be partially or solely accounted for by these variables. We hypothesised that greater paternal responsiveness at 12 months would be associated with greater infant development at 18 months, and that this association would remain after controlling for multiple confounding variables.

ii) The association between paternal low mood at 8 months and observed paternal responsiveness at 12 months within a non-clinical sample. A range of possible confounding factors were explored in relation to the main association. This included maternal low mood; paternal education; paternal involvement; conflict in the parental relationship; and infant characteristics (temperament, gender and birth order). We expected lower paternal mood at 8 months to be associated with lower paternal responsiveness at 12 months. Due to the limited literature, we did not hypothesise about the impact of confounding factors.

Method[2]

Avon Longitudinal Study of Parents and Children (ALSPAC)

The current research used data collected within an on-going longitudinal cohort study: ALSPAC[3]. ALSPAC has investigated a wide range of influences on child development by collecting comprehensive data on parents and their children from early pregnancy into adulthood. Pregnant women living in the former county of Avon with an estimated delivery date between April 1991 and December 1992 were recruited to the study; resulting in an initial cohort of 14,541 pregnant women and a sample of 13,988 infants 12 months after birth.

A sub-sample of infants (randomly selected from the last 6 months of births between 6th June 1992 and 11th December 1992) were invited to attend 'Children in Focus' (CIF) clinics for more detailed observational assessments at 4, 8, 12 and 18 months and at further intervals afterwards.

Sample

Participants of the current study are a sub-sample of the 1241 parent-infant pairs that participated in an observed and video-recorded parent-child interaction task at the 12 month CIF clinic in 1993. Invitations to the clinic were directed to the infant and 96% were accompanied by their mothers, resulting in 1194 mother-infant interactions being observed. A small proportion of infants (4%) were accompanied by their fathers who participated in the observed and videoed interaction task. These 47 father-infant pairs comprise the initial sample for the current research. In order to examine the association between paternal responsiveness and infant development, the sample was restricted to those who also had data on the child development measure at 18 months (n=42). This then reduced to 39 father-infant

[2] Extended method in Appendix D
[3] Ethical approval for this project was granted by the ALSPAC Law and Ethics Committee and Local Research Ethics Committee (see Appendix C).

dyads with complete data for the observed interaction, child development measure and the confounding variables; forming the complete case sample for the first and second hypotheses.

Of the original 47 father-infants pairs who had completed the observed interaction, 38 also had questionnaire data on paternal low mood at 8 months. This then reduced to a complete case sample of 32 that also had complete data for all confounding variables required to investigate the association between paternal low mood and paternal responsiveness.

The representative nature of the original ALSPAC sample was investigated by comparison with the 1991 National Census data of parents with infants under 12 months who were resident in the former county of Avon. The ALSPAC sample had a slightly greater proportion of families who were married or cohabiting; home owners; or who owned a car. According to previous ALSPAC research, the mothers who attended the 12 month CIF clinics with their infants were on average 1 year older, delivered 1 week later, 5% more likely to be primiparous, had a higher level of educational achievement, were 7% more likely to be married and more likely to have breastfed their infant than the ALSPAC sample at large (Pearson et al., 2011). Social-demographic characteristics of the fathers who attended the CIF clinic at 12 months (and their index families) were compared to the families where a mother attended the clinic with her infant (Table 1).

Table 1

Sample demographics

Variable (Mean (Sd) or %)	**Infant accompanied to clinic by:**		**P value**
	Mother (n=1194)	**Father** (n=47)	
% Female infant	46%	49%	.673
Gestation at delivery (weeks)	40(1.6)	40(2.1)	.991
% First born child	46%	48%	.83
% Low birth weight	4%	4%	.873
Temperament	16 (5.9)	17 (6.4)	.2081
Maternal age at delivery (years)	29(4.5)	30(4.5)	.1108

Maternal educational attainment			
% Degree	15%	25%	.057
% A or O level	65%	66%	
% Vocational or CSE	21%	9%	
Maternal social class			
% High social class	38%	53%	.099
% Mid social class	52%	34%	
% Low social class	10%	13%	
Maternal employment			
% paid employment since birth	47%	74%	<.001*
Maternal low mood			
EPDS score	5(4.5)	6(4.9)	.1625
% Maternal depression	10%	17%	.606
Paternal age at delivery (years)	30(6.5)	33(8.2)	<.001*
Paternal educational attainment			
% Degree	20%	33%	.101
% A or O level	57%	59%	
% Vocational or CSE	23%	10%	
Paternal social class			
% High social class	49%	45%	.732
% Mid social class	39%	45%	
% Low social class	12%	10%	
Paternal employment status			
% Employed	88%	72%	<.01*
% Unemployed seeking job	7%	13%	
% Full time education	1%	5%	
% Looking after home	1%	3%	
Paternal involvement			
% Take care of infant on own	73%	76%	.717
Hours per week father is sole carer	10.5 (12.8)	18 (14.5)	<.001*
Paternal low mood			
EPDS score	3(3.7)	3(3.5)	.7927
% Paternal depression	7%	8%	.671
Parental relationship satisfaction			
Couple conflict	10 (2)	10 (2)	.5944
% Married	83%	89%	.260

Note. This table was completed using all available data (% reflects proportion of available data). Variables are fully described in 'Measures'.

Measures

Paternal responsiveness at 12 months. At the 12 month CIF clinic, fathers and their infants were observed and videotaped interacting while reading a picture book. This was undertaken within a living room-style set up at a university laboratory. Fathers were instructed to share the picture book with their infants on the sofa "as they would at home",

and to continue until the infant had become "bored, tired or until you think s/he's had enough". Interactions ranged from 1 to 10 minutes long, with a mean duration of 4 minutes. The interactions were originally rated live by a trained observer using the Thorpe Interaction Measure (Thorpe, Greenwood, & Rutter, 2003).

For the current research, paternal responsiveness was measured by re-coding the videos of the father-infant interactions using a more in-depth and well validated observational tool: The Mellow Parenting Coding System (MPCS; Puckering, 2001). The MPCS is an event sampling observation tool which measures a range of positive and negative aspects of parent-infant interactions, including responsiveness.

The videos of father-infant interactions were coded by the lead author following completion of a training course facilitated by the author of the MPCS, Dr Christine Puckering. Further information on the MPCS definition of responsiveness, codes used in the scale, and application to the book-sharing task can be found in Appendix D. Every instance of defined behaviour was coded at 10 second intervals; producing a continuous score of positive responsiveness behaviours per interaction, with higher scores indicating greater paternal responsiveness. Due to variation in the length of the interactions, scores were standardised by dividing each fathers' responsiveness score by the duration of the interaction; proving a paternal responsiveness per minute score.

Reliability. In order to examine inter-rater reliability the majority of videoed father-child interactions (32 out of 47 videos; 68%) were rated independently by a second observer who had also completed the MPCS training. As variation in the duration of the interactions could confound the inter-rater comparison, inter-rater agreement was calculated using both raw and standardised scores. Substantial agreement between the two raters was achieved. Inter-rater agreement for the raw paternal responsiveness score was .83 ($p<.001$) using an

intra-class correlation co-efficient and .83 (p<.0001) with Pearson's correlation co-efficient; while agreement for the standardised scores was reduced but acceptable at .66 (p=.001) and .66 (p<.001) for intra-class and Pearson's r coefficients respectively.

Validity. The convergent validity of the paternal responsiveness dimension of the MPCS was examined in the current sample via comparison with the original live ratings of responsiveness using the Thorpe Interaction Measure (TIM; Thorpe, Greenwood & Rutter, 2003). Although the scale could be criticised for being crude, it has good inter-rater reliability, concurrent validity and predictive validity with infant development when used with mothers (Pearson et al., 2011). The TIM yields categorical ratings of parental responsiveness in the following domains: Verbal behaviour (negative, neutral or positive); nonverbal behaviour (negative, neutral or positive); and warmth (cool, neutral or warm). Table 2 shows that categorisation of fathers' responses using the TIM was related to fathers' positive responsiveness scores on the MPCS; demonstrating concurrent validity.

Table 2

Paternal responsiveness (Mellow Parenting Coding System) according to categorisation by Thorpe Interaction Measure

Thorpe Interaction Measure	**Mellow Parenting Coding System** Paternal responsiveness scores (rate per minute) Mean (Sd)	**P level** (t-test)
Non-verbal responses		
'Neutral' (n=21)	7.9 (4.1)	p=.0451
'Positive' (n=22)	10.5 (4.3)	
Verbal responses		
'Neutral' (n=11)	5.2 (3.2)	p=.0001
'Positive' (n=31)	10.7 (3.8)	
Warmth		
'Warm' (n=27)	8.6 (3.8)	p=.0288
'Very warm' (n=11)	11.9 (4.8)	

Infant development at 18 months. Infant development was assessed in the 18 month CIF clinic using the Griffiths Scales of Infant Mental Development (Griffiths, 1996). This assessment measures five areas of infant mental development for infants aged 0-2: Locomotor, personal-social, hearing and language, eye and hand coordination and performance skills[4]. Eight qualified and trained psychometrists employed by ALSPAC performed the Griffiths assessments. Each infant was assessed during a play session of approximately 50 minutes duration. Inter-rater consistency was established by tester observation and by repeatedly comparing each tester's scoring of a single assessment. The scores from the five subscales were standardised by adjusting them for the infant's age at assessment. Standardised subtest scores were then averaged to form a developmental quotient (DQ). The standardised DQ scores have a mean of 100 and a standard deviation of 12.8. Higher scores indicate better performance. Common factor analysis examining the underlying dimensions of the Griffiths has identified one single factor (Luiz, Foxcroft, & Stewart, 2001); therefore only the overall DQ score was analysed.

Paternal low mood at 8 months. Paternal low mood was measured using the Edinburgh Post-natal Depression Scale (Cox et al., 1987)[5], which was completed 8 months after the infant's birth. The EPDS is a 10-item self-report measure commonly used to screen for depression in community samples (Cox et al., 1987). Although the EPDS was developed to screen for post-natal depression in women, it has also been validated as a screening measure for men (Edmondson et al., 2010; Matthey et al., 2001), and has been used to measure depression in fathers at various time-points in the perinatal period and in the child's first year of life (e.g. Ramchandani et al., 2008). There is evidence for good test–retest

[4] Further information in Appendix D Extended Method
[5] EPDS can be found in Appendix F

reliability of the EPDS in women (Guedeney and Fermanian, 1998), and scores in men show reasonable stability over time (Ramchandani et al., 2008). Scores >10 have been found to identify depression in fathers, with high sensitivity (89.5%) and specificity (78.2%; Edmondson et al., 2010). The EPDS has also been used as a continuous measure of .low mood in mothers (Green, 1998), which arguably provides more sensitive information than using a dichotomy of 'depressed' and 'not depressed', and may be particularly useful in a non-clinical samples. In the current research, the EPDS was used as a continuous scale; dichotomising scores was performed for descriptive statistics only. Each item is scored on a 4-point scale (0-3) indicating the intensity of the experience of each statement within the previous seven days. Scores range from 0-30, with higher scores indicating lower paternal mood.

Confounding variables. Potential confounding variables for both research questions were derived from mother and father-reported questionnaire data collected at various time-points:

- *Infant development at 6 months:* Infant development 6 months was assessed via a mother-reported questionnaire of 42 items derived from the Denver Developmental Screening Test (Frankenburg et al., 1971)[6]. Age-adjusted scores range from 0-126, with higher scores indicating more advanced development.
- *Paternal education*: Fathers' highest level of educational attainment was self-reported at 18 weeks gestation. This was categorised as follows: 0=Vocational or CSE, 1=High school level education (O' level or A' level), or 2=University level education).
- *Paternal involvement:* Paternal involvement in infant care was mother-reported at 8 months post-birth on two questionnaire items: *'Father cares for infant when mother is*

[6] Further information in Appendix D: Extended Method

absent' (0=No, 1=Yes); and *'Hours per week that father cares for infant when mother is not there'.*

- *Maternal low mood*: This was mother-reported at 8 months using the EPDS (Cox et al., 1987) as a continuous measure. For the purposes of demographic comparisons only, mothers' scores were dichotomised as 'depressed' and 'non-depressed' using a cut off score of >12 to indicate risk of depression, which has been shown to identify women likely to meet diagnostic criteria for a diagnosis of major depression with a high specificity (95.7%) and sensitivity (81.1%; Murray & Carothers, 1990).
- *Parity*: Mother-reported at birth (1= 'first born', 2= not 'first born).
- *Infant temperament:* Mother reported using the 'Mood' subscale of the Carey Temperament Scales (Carey & McDevitt, 1978). Scores range from 1 to 44, with higher scores reflecting a more difficult temperament.
- *Couple conflict:* A relationship satisfaction questionnaire was completed by fathers at 8 months. The 13-item questionnaire, based on the work of Rutter and Quinton (1984), comprises two subscales of self-reported relationship satisfaction; conflict and affection. Only fathers' ratings of couple conflict were used. The questionnaire items yields frequency scores of reported aggression on a likert scale. High scores represent low conflict; with scores ranging from 3-15.

Analysis Strategy

Descriptive analysis. In order to describe the study sample and investigate whether the current sample differed from the rest of the 12 month CIF sample (when mothers accompanied their infants), group comparisons of social-demographic variables were carried out using t-tests for continuous data and Chi^2 comparisons for categorical variables. Bivariate

correlations were carried out for all combinations of the independent, dependent and potentially confounding variables using Pearson's R for associations between continuous variables and Spearman's rho for associations between continuous and categorical or two categorical variables.

The association between paternal responsiveness and infant development. Linear regression analyses were undertaken to test the hypotheses that greater observed paternal responsiveness at 12 months would be associated with greater infant development at 18 months, and that this effect would remain after controlling for confounding variables. The independent variable of paternal responsiveness and the dependent variable of infant development are continuous variables. The analysis was initially performed with all available data for the independent and dependent variables (n=42), this was then repeated on the complete case sample (n=38), who also had complete data for the confounding variables. Analyses were then repeated on the complete case sample, controlling for infant development at 6 months, paternal education and paternal involvement. All of the confounding variables were included in separate models in order to assess their relative influence on the main association, and finally in a complete model, incorporating all confounders.

The association between paternal low mood and paternal responsiveness. Linear regression analyses were also conducted to investigate the final hypothesis; that lower paternal mood at 8 months would be associated with lower paternal responsiveness at 12 months. Paternal low mood (independent variable) and paternal responsiveness (dependent variable) are continuous variables. Analyses were first performed with all available data for the independent and dependent variables (n=38), and then limited to the complete case sample (n=32). Analyses were then repeated on the complete case sample, controlling for maternal low mood, paternal education, paternal involvement, couple conflict, infant gender,

parity and infant temperament. As above, confounding factors were included in separate models to assess their relative influence. Finally, a model including only the confounders that had influenced the main association was carried out (all confounders were not included together as the study was under-powered to do this).

Results[7]

Descriptive Analysis

Sample demographics. Table 1 shows the demographic data for the 47 father-infant dyads forming the initial sample for this research. Fathers' mean age at infant birth was 33, the vast majority of whom were married (89%), had completed education to 'A' level standard or higher (92%), were of mid or high social class (90%), were employed (72%), took sole care of their infant at times when the infants' mother was absent (76%) for an average of 18 hours per week. Three fathers (8%) scored above 10 on the EPDS when their infant was 8 months, indicating likely clinical depression. Of the infants, 49% were female, 48% were first born, 4% were of a low birth weight and the mean gestation was 40 weeks. Infants scored between 5-33 on a temperament scale (ranging from 0-44; with 44 as most difficult), with a mean score of 17; between 42-105 on a screening measure of infant development at 6 months (ranging from 0-126; with higher scores indicating more advanced development), with a mean score of 69; and between 82-128 on a measure of infant development at 18 months, with a mean score of 107.7 (in the average range).

Compared with the rest of the 12 month CIF clinic sample, the current sample of infants had mothers who were more likely to have undertaken paid employment since their

[7] Extended results in Appendix E

birth. Fathers in the current sample were more involved in their infants' care; were on average 3 years older; and were slightly more likely to be unemployed and slightly less likely to be employed).

During the videoed father-infant interactions (which varied in duration), fathers exhibited between 4 and 116 responsive behaviours, with a mean of 39 (SD=25.8) responsive behaviours per interaction. Post-standardisation, fathers' scores ranged from 1 to 19 responsive behaviours per minute, with a mean of 9 (SD=4.2).

Bivariate correlations. Table 3 shows a correlation matrix of all variables. The significance of the associations should be considered cautiously due to the relatively large number of correlations undertaken within the modest sample size. Fathers were more responsive towards 'first born' infants and infants with more difficult temperaments, although this association was only marginally significant. Higher paternal educational attainment was marginally associated with more advanced infant development at 18 months. Lower paternal mood (as indicated by higher scores on the EPDS) at 8 months was associated with less involvement in infant care and *higher* paternal responsiveness at 12 months.

The association between paternal responsiveness and infant development

As can be seen in Table 4, observed paternal responsiveness at 12 months was not related to infant development at 18 months. Single adjustments for paternal education and prior infant development reduced the strength of the non-significant association further. Adjusting for paternal involvement increased the strength of the association between paternal responsiveness and later infant development, but the main association remained non-significant.

Table 3

Correlation matrix of independent, dependent and confounding variables using Spearman's rho and Pearson's r

	Paternal resp'ness	**Paternal low mood**	**Infant dev'18m**	**Maternal low mood**	**Infant dev' 6m'**	**Paternal educ'n**	**Paternal involve't**	**Couple conflict**	**Parity**	**Infant Temp't**
Paternal resp'ness	1 (n=47)									
Paternal low mood	**0.33 p<.05**	1 (n=38)								
Infant dev' 18m'	0.06 p=.6935	-0.03 p=.8553	1 (n=42)							
Maternal low mood	0.13 p=.3668	0.11 p=.5060	0.00 p=.9852	1 (n=46)						
Infant dev' 6 m'	0.17 p=.2764	0.10 p=.5733	0.24 p=.1414	0.10 p=.5193	1 (n=45)					
Paternal educ'n	0.07 p=.16678	0.04 p=.8248	0.28 p=.0682	0.20 p=.1903	0.27 p=.0811	1 (n=46)				
Paternal involve't	0.02 p=.8762	-0.29 p=.0877	-0.25 p=.1196	0.12 p=.4327	**0.31 p<.05**	0.05 p=.7690	1 (n=45)			
Couple conflict	0.01 p=.9817	-0.13 p=.577	0.15 p=.3915	**-0.43 p<.01**	0.21 p=.207	0.08 p=.6310	-0.07 p=.6862	1 (n=38)		
Parity	-0.25 p=.0906	0.22 p=.1909	-0.03 p=.8477	0.26 p=.0790	-0.26 p=.0860	0.05 p=.7407	-0.26 p=.0853	-0.19 p=.2418	1 (n=46)	
Infant temp't	0.28 p=.0634	0.05 p=.7551	0.08 p=.6212	0.07 p=.6394	0.03 p=.8228	0.19 p=.2154	**0.31 p<.05**	0.20 p=.240	-0.14 p=.3708	1 (n=45)

Note: The data-set contained missing data that varied across variables; correlations represent all available data. Correlations with $p \leq 0.05$ appear highlighted in bold.

Table 4

Regression analyses showing no significant association between paternal responsiveness at 12 months and infant development at 18 months

Effect of Paternal responsiveness at 12 months	**Crude effect** (all available data; n=42)	**Crude effect** (complete case sample; n=39)	**Adjusted 1** (complete cases)	**Adjusted 2** (complete cases)	**Adjusted 3** (complete cases)	**Adjusted 4** (complete cases)
Child development						
Standardised beta coefficient	0.05	0.06	0.10	0.09	0.21	0.10
(95% CI)	(-0.19-0.28)	(-0.19-0.31)	(-0.21-0.28)	(-0.22-0.28)	(-0.17-0.32)	(-0.21-0.27)
p level	p=.69	p=.642	p=.784	p=.818	p=.554	p=.78

Note: Adjusted 1=controlled for infant development at 6 months only. Adjusted 2=controlled for paternal education only. Adjusted 3=controlled for paternal involvement only. Adjusted 4=controlled for prior infant development, paternal education and paternal involvement.

The association between paternal low mood and paternal responsiveness

As can be seen in Table 5, paternal low mood was associated with paternal responsiveness, but this was not in the hypothesised direction. Lower paternal mood (indicated by higher scores on the EPDS at 8 months) was associated with greater paternal responsiveness at 12 months. For every standard deviation increase in fathers' EPDS score (3.5), there was an increase of approximately two responsiveness behaviours per minute during the father-infant interaction; representing a standardised effect size of 0.32 standard deviations.

Single adjustments for maternal depression, paternal education, paternal involvement, parental conflict, infant gender and infant temperament did not affect the significance of the association. However, the association was attenuated once maternal depression and paternal education were included together in the model.

Table 5

Regression analysis of the association between low paternal mood at 8 months and paternal responsiveness at 12 months; showing that each standard deviation increase on the EPDS scale is associated with increased paternal responsiveness

Effect of paternal depressive symptoms	**Crude effect** (all available data; n=38)	**Crude effect** (complete case sample; n=32)	**Adjusted 1** (complete cases)	**Adjusted 2** (complete cases)	**Adjusted 3** (complete cases)
Paternal responsiveness					
Standardised beta coefficient (95% CI)	0.32 (0.02-0.63)	0.36 (0.04-0.69)	0.35 (0.02-0.67)	0.35 (0.008-0.67)	0.36 (0.03-0.70)
p level	p=.042	p=.028	p= .041	p= .043	p=.034
Effect of paternal depressive symptoms	**Adjusted 4** (complete cases)	**Adjusted 5** (complete cases)	**Adjusted 6** (complete cases)	**Adjusted 7** (complete cases)	
Paternal responsiveness					
Standardised beta coefficient (95% CI)	0.36 (0.02-0.70)	0.38 (0.05-0.71)	0.36 (0.02-0.69)	0.31 (-0.02-0.66)	
p level	p=.036	p=.024	p=.035	p=.071	

Note: Adjusted 1=controlled for maternal depression only. Adjusted 2=controlled for paternal education only, Adjusted 3=controlled for paternal involvement only, Adjusted 4=controlled for couple conflict only, Adjusted 5=controlled for parity only, Adjusted 6=controlled for temperament only, Adjusted 7=controlled for maternal depression and paternal education only (as these confounders had an influence on the main association).

Discussion

Measurement of paternal responsiveness

Paternal responsiveness at 12 months was measured using the Mellow Parenting Coding System (Puckering, 2001); a measure previously used with mothers and infants. To our knowledge this is the first study to do this. Convergent validity of the positive responsiveness dimension was demonstrated with the Thorpe Interaction Measure (Thorpe, Greenwood, & Rutter, 2003); and substantial inter-rater agreement was achieved by independent raters. This indicates that the MPCS is a reliable and valid measure of positive responsiveness for fathers. Paternal responsiveness scores had a large range and were fairly normally distributed. The continuous nature of the scale provides increased sensitivity to detect small differences in paternal responsiveness, making it a suitable tool for research in non-clinical samples and exploratory research with fathers. Future research could extend the validation of the scale for fathers in free-play interactions, clinical samples and for the other MPCS dimensions.

Paternal responsiveness and infant development

The hypothesis that a higher degree of observed paternal responsiveness at 12 months would be associated with greater infant development at 18 months was not confirmed. However, this must be considered in light of the limitations of the study. Firstly, the modest sample size means the study did not hold sufficient statistical power to detect small effect sizes. Therefore, the null finding may represent a type-two error. The point estimate for the association suggests a very small effect size of approximately 0.05 of a standard deviation increase in Griffiths score for each standard deviation increase in paternal responsiveness.

Secondly, it has been suggested that fathers may have a specific influence on infants' development via facilitating 'secure exploration' during sensitive and challenging *play* (Grossman et al., 2002). Therefore, measurement of paternal responsiveness during the book-sharing situation may lack ecological validity. Indeed, previous research has found that different interaction settings can influence whether a relationship between father-infant interactions and infant outcomes is detected (Ramchandani et al., 2013).

Furthermore, the infants and their families that attended the 12 month CIF clinic have been shown to vary from the rest of the ALSPAC sample (Pearson et al., 2011). Infants that attended the 12 month CIF clinic had more highly educated mothers with higher social class who were more likely to have breastfed (all factors known to influence infant development in the literature; Pearson et al., 2011). The current sample was found to differ further; for example, they were a select sample of fathers who were very involved in their infant's care. Paternal involvement has been consistently shown to be associated with positive outcomes for children (Sarkdaki et al., 2008). Therefore, it is not surprising that the infants were relatively high achieving. In fact, all but one infant scored within or above the 'normal' range on the measure of infant development at 18 months. This may have resulted in a 'ceiling' effect. In two-parent families with highly involved fathers and well-educated parents, the degree of paternal positive responsiveness is not associated with later infant development as there are many protective factors. The null finding should be generalised to those from more disadvantaged groups with caution.

Methodological issues notwithstanding, it remains possible that the result reported here is reflective of a 'true' null association between paternal responsiveness and later infant development. Consequently, some speculation regarding possible explanations of this in relation to previous findings is warranted. The finding may reflect the greater influence of

mothers during infancy. Mothers are responsible for a greater proportion of infant care than fathers, and the impact of maternal responsiveness on later infant development has been clearly evidenced (Bakermans-Kranenberg, et al., 2003; Pearson et al., 2011). Fathers may not influence their infants' development through the same pathways as mothers.

The finding that a paternal responsiveness was not associated with infant development is inconsistent with previous cross-sectional studies that have identified positive concurrent associations (Black et al., 1999; Connor et al., 1997; Easterbrooks & Golding, 1984; Kelley et al., 1998; Shannon et al., 2002; Shannon, et al., 2006; Tamis-LeMonda et al., 2004). The few published longitudinal studies have produced mixed results (Magill-Evans & Harrison, 1999; Shannon, et al., 2006; Tamis-LeMonda et al., 2004). The results of this study are consistent with Magill-Evans and Harrison (1999) who found that paternal responsiveness during a teaching interaction at 12 months was not associated with infant development at 18 months in a sample of term and pre-term infants. It is noteworthy that Magill-Evans and Harrison (1999) utilised a composite measure of infant development; an identical time period between measurement of responsiveness and infant development; and included infants of the same age as the current research. This study therefore extends the work of Magill-Evans and Harrison (1999) by finding that paternal responsiveness at 12 months was not related to infant development at 18 months in a low-risk sample.

However, the results of the current study are inconsistent with Tamis-LeMonda et al. (2004) who found a positive association between paternal responsiveness at 24 months and later infant development and early language skills at 36 months; independently of mother-infant interactions, parent educational attainment and infant development at 24 months. A possible explanation is that paternal responsiveness becomes more influential in the second to

third year of an infants' life rather than at younger ages when infants may be more dependent on their mothers (Clarke-Stewart, 1978).

Alternatively, variation in the father-infant observation task may explain the inconsistencies. Tamis-LeMonda et al. (2004) and Shannon et al. (2006) measured paternal responsiveness during father-infant play and found evidence of a positive relationship with later development, and a marginally significant association with social and communication skills respectively. Magill-Evans and Harrison (1999) measured paternal responsiveness during a teaching task and the current research utilised a book-sharing task; both of which yielded non-significant results.

It is unclear whether the finding of no association between paternal responsiveness and later infant development reflects a true null relationship. Until future research can clarify this, clinicians working with parents of infants, who hope to improve infant development (e.g. health visitors, therapists within infant mental health services), may wish to concentrate their resources on enhancing the mother-infant relationship and supporting father involvement.

Further longitudinal research using larger samples of fathers from a range of demographic backgrounds; infants of varying ages; measuring both maternal and paternal responsiveness in different settings (including play); that control for the earlier developmental ability of the infant, paternal involvement and parental education could further clarify whether and under which circumstances paternal responsiveness might be associated with later infant development.

Paternal low mood and paternal responsiveness

Contrary to our hypothesis, the current study found that fathers with lower mood at 8 months post birth were *more* responsive towards their infants at 12 months; which some studies have found is concurrently and longitudinally associated with positive infant attachment and development (Black et al., 1999; Connor et al., 1997; Easterbrooks & Golding, 1984; Kelley et al., 1998; Lucassen et al., 2011; Shannon et al., 2002; Shannon et al., 2006; Tamis-LeMonda et al., 2004).

It is noteworthy that the effect size for the association was moderate. For every standard deviation increase in fathers' EPDS score, there was 0.32 of a standard deviation increase in paternal responsiveness.

Before considering this finding in more detail, a number of limitations of the study must be acknowledged. Due to the modest sample size, this could be a chance finding. A relatively large number of statistical tests were undertaken in this exploratory study, raising the possibility of type one errors. The finding therefore needs to be replicated in larger studies and until then should be regarded preliminary.

A major limitation is that paternal low mood was measured at 8 months, which is 4 months prior to the observed father-infant interaction. Fathers' experience of low mood at the time of the interaction is therefore unknown. Nevertheless, fathers' scores have been shown to be relatively stable over time in previous research (Ramchandani et al., 2008). Despite the longitudinal design, it is not possible to conclude that low paternal mood *determine*s greater paternal responsiveness. Perhaps responsive fathering leads to increased distress, due to the inherent challenges and emotional energy involved in being a responsive

parent. The lack of a baseline measure of paternal responsiveness at 8 months further limits the ability to infer causality.

However, it is possible that the finding does reflect a true association. It is important to clarify this does not mean that *clinical depression* is associated with greater paternal responsiveness. Paternal low mood was a continuous variable measured within a community sample. Just three fathers scored in the range considered to identify risk of depression. A descriptive investigation of the data indicated that two out of the three fathers who were likely to be depressed achieved a paternal responsiveness score that was above the group mean. This tentatively suggests that depressed fathers were not outliers; their responsiveness data was consistent with the average pattern of the data. However, with just three fathers likely to be depressed, we are unable to draw any firm conclusions about paternal depression so instead refer to 'paternal low mood'.

The finding that lower paternal mood was associated with greater paternal responsiveness remained after controlling for several confounding variables. Single adjustments for maternal depression, paternal education, paternal involvement, couple conflict, gender, parity and temperament did not affect the strength of the relationship, indicating that the association is not solely explained by any of these factors. However, the association was attenuated once maternal depression and paternal education were included in the model. One explanation is that part of the association is explained by maternal low mood. Paternal low mood is known to coexist with maternal low mood (Edhborg et al., 2005) and in families where the mother is low in mood the father may take on a more responsive role with the infant to compensate (Edhborg et al., 2003). Paternal education may also explain part of the association. Fathers with lower levels of education may be more at risk of low mood and

greater paternal education has been found to be associated with greater quality of father-infant interactions (Shannon et al., 2006).

As outlined above, the sample of infants' included in this research differed from the wider ALSPAC sample and the 12 month CIF sample. The select group of educated, highly involved fathers with high social-economic status are likely to have a range of resources and coping strategies available to them, which may serve to protect the quality of the father-infant interaction or allow the father to compensate when he is experiencing non-clinical low mood. The findings may not be generalisable to less involved or educated fathers or those experiencing social-economic adversity.

The finding that lower paternal mood was associated with greater paternal responsiveness is inconsistent with intuitive ideas that low mood leads to 'positivity suppression' (Jacob & Johnson, 2001) and reduced 'emotional energy' (Goldberg et al., 2002) for father-infant interactions and two previous studies that found associations between paternal depression (Sethna et al., 2012) and non-clinical low mood (Zaslow et al., 1985) and reduced observed paternal responsiveness with younger infants. The current study is more consistent with the work of Field et al. (1999) who found no differences in depressed and non-depressed fathers' responsiveness and that depressed fathers were more responsive than depressed mothers. Perhaps fathers are more able to compensate for low mood due to a more playful interactive style, or due to spending relatively less time with their infants (Hossain, Field, Malphurs, & DelValle, 1995).

In order to shed further light on the unexpected finding that lower paternal mood was associated with greater paternal responsiveness, it is necessary to consider what the EPDS may be measuring in a non-clinical sample. One possible explanation is that in a sample of non-depressed fathers, scores on the EPDS are associated with mentalising ability. Optimal

mentalising function occurs when affect arousal is moderate; intense high emotional arousal or detached low emotional arousal is associated with reduced mentalising ability (Bateman & Fonagy, 2010). Fathers who are not clinically depressed, but report a degree of negative emotional symptoms on the EPDS may have greater mentalising ability (as they are aware of and able to report on their own emotions), thus making them more able to reflect on and interpret their infants cues and respond appropriately. In contrast, fathers reporting a complete absence of low mood may be emotionally detached with poor reflective function; resulting in less sensitive responsiveness towards their infants. This is supported by the finding that mothers who scored zero or one on a self-report measure of depression were less responsive towards their infants than those with higher scores (Field, Morrow, Healy, Foster, Adlestein, & Goldstein, 1991). If fathers' low mood intensifies to such a degree that it becomes acute as in the case of clinical depression, the fathers' reflective function is likely to become impaired also resulting in reduced sensitive responsiveness. As such, the relationship between paternal low mood and paternal responsiveness may be of a 'u-shaped' nature; where high or low extremes of low mood are associated with lower responsiveness, while those who are not depressed but are able to reflect on their emotions may be more responsive towards their infants. This is a purely speculative explanation as this study did not measure reflective function specifically. Researchers interested in exploring this further could measure fathers' reflective function in addition to low mood and responsiveness. This could inform whether mentalisation-based parent-infant therapy interventions (e.g. Slade et al., 2006) could be effective in increasing paternal responsiveness in fathers who struggle to reflect on and express their emotions.

This study indicates that clinicians working with parents and infants should consider that fathers who achieve very low scores on measures of low mood may be at risk for low

positive responsiveness. Equally, when screening for depression in fathers it may be useful to remain open to the possibility that fathers who appear responsive towards their infants may still be experiencing low mood.

Conclusion

This exploratory longitudinal study builds on the small body of research on fathers' observed interactions with their infants. No evidence was found for an association between paternal responsiveness and later infant development. Due to limitations in the study it is unclear whether this reflects a true null relationship. Unexpectedly, we did find evidence for an association between lower paternal mood and *higher* paternal responsiveness. This finding needs replication within larger studies and should be considered preliminary at this stage. One explanation is that fathers who are not depressed but are emotionally aware may be more responsive towards their infants due to their ability to mentalise. Clinicians should consider that fathers who achieve very low scores on measures of low mood may be at risk for low paternal responsiveness.

Strengths of the study include the selection of some well validated observational measures, the use of a longitudinal design, and the consideration of potentially confounding variables. Observational research in to the nature and correlates of father-infant interactions is rare, meaning that researchers are "working in the dark" (p. 97; Shannon et al., 2002). It is hoped that this exploratory study will 'shed some light' on areas which might benefit from hypothesis testing with stronger methodologies. Specifically, future research could explore the nature of the relationship between paternal low mood, reflective function and paternal responsiveness; and/ or paternal responsiveness and later infant development in larger

longitudinal studies which measure father-infant interactions during play and control for possible confounding factors.

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All manuscripts must include an abstract containing a maximum of 250 words typed on a separate page. After the abstract, please supply up to five keywords or brief phrases.

The manuscript title should be accurate, fully explanatory, and preferably no longer than 12 words. The title should reflect the content and population studied (e.g., "family therapy for depression in children"). If the paper reports a randomized clinical trial, this should be indicated in the title, and the CONSORT criteria must be used for reporting purposes.

Research manuscripts and review and theoretical manuscripts that provide creative and integrative summaries of an area of work relevant to family psychology should not exceed

30–35 pages, all inclusive (including cover page, abstract, text, references, tables, figures), with margins of at least 1 inch on all sides and a standard font (e.g., Times New Roman) of 12 points (no smaller). The entire paper (text, references, tables, figures, etc.,) must be double spaced. References should not exceed 8 pages.

Brief reports are encouraged for innovative work that may be premature for publication as a full research report because of small sample size, novel methodologies, etc. Brief reports also are an appropriate format for replications and for clinical case studies. Authors of brief reports should indicate in the cover letter that the full report is not under consideration for publication elsewhere. Brief reports should be designated as such and should not exceed a total of 20 pages, all inclusive. References should not exceed 8 pages.

Manuscripts exceeding the space requirement will be returned to the author for shortening prior to peer review.

All research involving human participants must describe oversight of the research process by the relevant Institutional Review Boards and should describe consent and assent procedures briefly in the Method section.

It is important to highlight the significance and novel contribution of the work. The translation of research into practice must be evidenced in all manuscripts. Authors should incorporate a meaningful discussion of the clinical and/or policy implications of their work throughout the manuscript, rather than simply providing a separate section for this material.

Masked Review

The *Journal of Family Psychology*® uses a masked reviewing system for all submissions. The cover letter should include all authors' names and institutional affiliations. However, in order to permit anonymous review, the first page of text should omit this information. This cover page should only include the title of the manuscript and the date it is submitted. Please make every effort to see that the manuscript itself contains no clues to the authors' identities.

Cover Letter

Authors should indicate in their cover letter that the work has not been published previously and is not under consideration for publication elsewhere. The relationship of the submitted manuscript with other publications and/or submissions of the author, if any, should be explained.

The cover letter should include a statement indicating that the manuscript has been seen and reviewed by all authors and that all authors have contributed to it in a meaningful way. The cover letter must include the full mailing address, telephone, fax, and email address for the corresponding author.

CONSORT Criteria

The *Journal of Family Psychology* requires the use of the CONSORT reporting standards (i.e., a checklist and flow diagram) for randomized clinical trials, consistent with the policy

established by the Publications and Communications Board of the American Psychological Association.

CONSORT (Consolidated Standards of Reporting Trials) offers a standard way to improve the quality of such reports and to ensure that readers have the information necessary to evaluate the quality of a clinical trial. Manuscripts that report randomized clinical trials are required to include a flow diagram of the progress through the phases of the trial and a checklist that identifies where in the manuscript the various criteria are addressed. The checklist should be placed in an Appendix of the manuscript for review purposes.
When a study is not fully consistent with the CONSORT statement, the limitations should be acknowledged and discussed in the text of the manuscript. For follow-up studies of previously published clinical trials, authors should submit a flow diagram of the progress through the phases of the trial and follow-up. The above checklist information should be completed to the extent possible, especially for the Results and Discussion sections of the manuscript.

Visit the CONSORT Statement Web site for more details and resources.

Appendix B: Ethical approval email from University of Exeter

Psychology Research Ethics Committee

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Email Marilyn.evans@exeter.ac.uk

To: **Sarah Coffey**

From: **Cris Burgess**

CC: **Rebecca Pearson, Jonathan Evans**

Re: **Application 2011/634 Ethics Committee**

Date: **18th June 2012**

The School of Psychology Ethics Committee has now discussed your application, ***2011/634 – The association between observed paternal responsiveness at 12 months and infant development at 18months .*** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (http://www.ex.ac.uk/admin/academic/datapro/). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

Cris Burgess

Chair of Psychology Research Ethics Committee

Appendix C: Extended method – Further Information on Measures

Mellow Parenting Coding System

The MPCS is able to measure up to six key dimensions of parent-infant interaction (each with a positive and negative pole): Anticipation, Autonomy, Responsiveness, Co-operation, Distress and Control). Although the primary variable under investigation in this study was positive paternal responsiveness, the other dimensions of the MPCS were also coded for the father-infant interactions. See Table C1 for detailed information on coding of responsiveness and Table C2 for definitions of the other commonly coded dimensions and behaviours observed in the father-infant book-sharing interaction.

To our knowledge, the MPCS has yet to be used with fathers in published research. The MPCS was chosen as it is used to measure parent-child interactions clinically and has been used in mother-infant research in community samples (Puckering, Mackintosh, Hickey & Longford, 2010; Puckering, Rogers, Mills, Cox & Mattsson-Graff, 1994; Robertson, Puckering, Parkinson & Wright, 2011). In research samples of mothers and infants it has been applied with good inter-rater reliability (kappa =0.82; Robertson et al., 2011); coherent inter-relationships between coding domains (Robertson et al. 2011); and has construct validity with the Thorpe Interaction Measure (Pearson et al., 2011). Furthermore, the event-sampling method (as opposed to categorical rating of the overall interaction) provides the potential for increased sensitivity to detect small differences in paternal responsiveness, making it a suitable tool for research in non-clinical samples and exploratory studies.

Table C1

Definition of positive responsiveness and codes used in Mellow Parenting Coding System (Puckering, 2001): Examples of behaviours coded as responsiveness in the father-infant book-sharing interaction

Dimension	Definition	Codes	Examples from the book-sharing interaction
Responsiveness	"Parent and child are responsive to each other, act in a reciprocal way and have playful interactions. Parent responds in a sensitive way to the child's independent activity. Parent or child may expand or make a cognitive elaboration to the other's current focus of interest. The expression of positive affect in a behavioural, verbal, tone or physical way is noted, as are displays of affect	**Mother link-Child Follow:** Parent expands on the child's or their own activity in such a way as to enlarge the child's understanding. Link must relate to the immediately preceding topic or activity. Child follows or responds. **Child link-Parent follow:** Child expands the activity or topic engaged in with parent. Parent responds, verbally or non-verbally in a way which indicates an awareness of child's behaviour. **Care-take:** parent proceeds with agenda while having playful interaction for 10 secs **Mother follow:** Parent responds in sensitive way to child's independent activity **Good parental timing:** Parents' behaviour demonstrates awareness of child's needs, shows sensitive anticipation. Actions which avert control or distress are coded as this. **Positive affect:** Parent expresses verbal approval of child's behaviour/ parent laughs or smiles/ affectionate touch/ joint cuddle/ gentle handling/ mutual affect/ positive tone	• Whilst infant is looking at the page, father points to a picture of a baby having a bath in the book and says "look" Or "You had a bath last night", "splash splash", infant responds • Infant points to picture of dog in the book and the parent says "Doggy"/ "Woof-woof" noise • Father and infant play peekaboo with book • Father comments "What's that?" in response to infant looking at a picture in the book • Father says "You don't feel like reading today?" when infant drops book on floor. • Father imitates a sound the infant makes • Infant taps the page and father taps the page • Father comments "Clever boy" when infant turns page/ smiles/ cuddles infant • Father smiles/ uses a positive tone/ cuddles infant

Table C2

Definitions of MPCS dimensions and behaviours commonly observed in book-sharing task

Dimension	Description	Applied to the book-sharing interaction
Anticipation	The child is prepared for changes in activity by facilitating a known routine, giving warning, providing information or distracting the child so that the parent's agenda is easier to achieve.	• Father comments "We're going to read a book now" • Father places infant in sitting position so they can read the book
Autonomy	Parent shows awareness of child's individuality, wishes, needs, timing or acknowledges feelings. Child is allowed to exercise choice, and behave spontaneously while parent monitors on-going activity. Parent offers encouragement or enables the child to complete their activity. The parent acknowledges/ responds to protests or complaints.	• Father watches and waits while infant flicks through the pages. • Father encourages infant to turn page of book independently e.g. "You can turn the page" or lifts page slightly so infant can do it. • Father asks infant "Are you finished?", "Are you tired?" • Father acknowledges infant protest (e.g. "You're more interested in the man aren't you? Shall we have a break?"
Negative Autonomy	Autonomy is not given in ways above. The parent is intrusive or child protest is ignored or dealt with in a negative way. Parent makes demands of child that are not appropriately matched to the child's developmental level or are badly timed (lacks synchrony).	• Infant looks bored and tries to get down from sofa. Father immediately lifts infant back on and resumes reading without commenting. • Infant engrossed in turning pages of book backwards/upside down, father snatches book and, says "No, it goes this way".

Note. Descriptions of MPCS dimensions adapted from Mills and Puckering (2001).

A summary of the mean and range of the raw scores and standardised scores for each dimension can be found in Table C3, confirming the continuous nature of the scale. Positive paternal responsiveness was the most frequently observed behaviour in the father-child interactions (ranging from 4-116 behaviours per interaction; averaging 1-19 per minute), followed by positive autonomy (range= 0-40 behaviours per interaction; averaging 0-5 per minute), positive anticipation (range= 0-21 behaviours per interaction; averaging 0-7 per minute) and negative autonomy (range=0-16 per interaction; averaging 0-4 per minute). Examples of positive cooperation, positive distress and all negative poles of dimensions except autonomy, were very infrequently observed in the book-sharing interaction and therefore were not analysed any further.

Table C3

Summary of Mellow Parenting Coding System subscale raw and standardized scores for father-infant interactions (n=47)

	Raw scores		**Standardised scores***	
MPCS Subscale	**Mean (Sd)**	**Range**	**Mean (Sd)**	**Range**
Total positive	56 (32.5)	6-143	13.37 (5.52)	3.88-27
Total negative	3 (3.8)	0-17	0.91 (0.99)	0-3.75
Positive responsiveness	39 (25.8)	4-116	9.32 (4.26)	1-18.58
Negative responsiveness	0 (0.5)	0-3	0.04 (0.16)	0-1.06
Positive anticipation	6 (5)	0-21	1.52 (1.39)	0-7

Negative anticipation	0 (0)	0-0	0 (0)	0-0
Positive autonomy	9 (8)	0-40	1.93 (1.21)	0-5.45
Negative autonomy	3 (3.6)	0-16	0.80 (0.92)	0-3.75
Positive cooperation	0 (0.1)	0-1	0.01 (0.05)	0-0.33
Negative cooperation	0 (0.2)	0-1	0.01 (0.07)	0-0.33

Note. Total positive and total negative scores are composites of all positive and negative dimensions respectively.

Table C4 details a correlation matrix showing relationships between the MPCS dimensions that were most frequently observed. Positive responsiveness was found to be positively correlated with positive anticipation and the total positive score, and negatively correlated with negative autonomy, but not related to positive autonomy. Positive autonomy was not associated with positive anticipation. The modest/ lack of correlations between individual dimensions suggest that they are assessing different aspects of father-infant interaction. As positive responsiveness was the most frequently observed behaviour on this occasion, the total positive score appeared to be heavily influenced by this.

Table C4

Correlation matrix: Relationships between MPCS dimensions (n=47)

	Positive responsiveness	**Positive autonomy**	**Positive anticipation**	**Total positive score**	**Negative autonomy**
Positive responsiveness	1				
Positive autonomy	-0.08 p=.6081	1			
Positive anticipation	**0.36** **p<.05**	0.24 p=.109	1		
Total positive score	**0.94** **p<.001**	0.19 p=.194	**0.59** **p<.001**	1	
Negative autonomy	**-0.30** **p<.05**	-0.06 p=.6926	0.15 p=.3106	-0.26 p=.08	1

The majority of videoed father-child interactions (32/47; 68%) were rated independently by a second trained observer in order to examine inter-rater reliability (Table C5). Due to the possibility that variation in the duration of the interactions may have confounded the comparisons, inter-rater agreement was calculated using both raw and standardised scores for each dimension. Substantial inter-rater agreement was achieved for the total positive score and positive responsiveness, with moderate agreement for positive anticipation. Raters did not reach an acceptable level of agreement on any of the negative poles of dimensions, positive cooperation or positive distress. This may be due to the relative infrequency of behaviours relating to these dimensions.

Table C5

Inter-rater reliability of Mellow Parenting Coding System for father-infant interactions

(n=47)

	Raw Scores Inter-rater agreement		**Standardised Scores Inter-rater agreement**	
Mellow Parenting Subscale	**Pearson's correlation coefficient p level**	**Intra-class correlation coefficient p level**	**Pearson's correlation coefficient p level**	**Intra-class correlation coefficient p level**
Total positives*	.84 p<.0001	.83 p<.001	.66 p<.001	.59 p<.001
Total negatives	.51 p=.01	.41 p=.001	0.56 p<.001	0.33 p=.016
Positive responsiveness*	.83 p<.0001	.83 p<.001	.66 p=.001	.66 p<.001
Negative responsiveness	-.12 p=.5030	-.07 p=.675	-.09 p=.644	-.14 p=.592
Positive autonomy	.92 p<.0001	.57 p<.001	.63 p<.001	.30 p=.001
Negative autonomy	.53 p=.0019	.44 p=.001	0.57 p=.001	.33 p=.016
Positive anticipation*	.59 p<.001	.60 p<.001	.57 p=.001	.58 p<.001
Positive cooperation	-	.00 p=.50	-	.00 p=.50
Negative cooperation	-.10 p=.57	-.05 p=.62	-.08 p=.652	-.03 p=.575
Positive distress	.70 p<.001	.59 p<.001	.85 p<0.01	.75 p<0.01
Negative distress	1 p<.001	1	1 p<0.001	1

Note: * indicates subscales that achieved moderate or substantial inter-rater agreement of standardized scores.

Positive paternal responsiveness was previously chosen as the primary independent variable based on prior literature and because previous research in mothers reports that the responsiveness dimension of MPCS is most strongly associated with infant development. As substantial inter-rater reliability was not achieved for positive or negative autonomy or anticipation, and as the total positive score was highly related to the positive responsiveness score, no further analysis was carried out with these variables.

Griffiths Scales of Infant Mental Development (Griffiths, 1996)

The Griffiths encompass the following six subscales:

- Locomotor: Gross motor skills including the ability to balance and to co-ordinate and control movements. Items include age-appropriate activities such as kicking and rolling (in the first month), and walking up and down stairs, running and jumping (in the second year).
- Personal-Social: Measures the developing abilities that contribute to independence and social development. Items for the early months include visual recognition of mother, following moving people with eyes and holding a spoon. Items at the older end of the 0-2 age range include using a spoon competently to feed self, asking for things at the table, the ability to open a door and helping to dress or undress self.
- Hearing and Language: Assessment of hearing (in the sense of active listening), receptive language and expressive language (or early pre-speech).
- Eye and Hand Co-ordination: Fine motor skills, manual dexterity and visual monitoring skills. Items include reaching for objects, grasping and other manipulative activities.

- Performance: Like the previous scale, deals with situations requiring some manual performance but focuses on the way in which such skills are applied in novel situations such as visio-spatial skills (including speed and precision). Items include clasping objects placed in hand, dropping one cube for a second, unwrapping to find a toy or cube, putting a lid back on a box and opening a screw toy.

Verbal descriptions of the Griffiths standard score ranges **(**Ivens & Martin, 2002) can be found in Table C5.

Table C5

Griffiths standard score ranges (Ivens & Martin, 2002)

Description	**Standard Score Range**
Very Low	<75
Low	75–82
Low Average	83–91
Average	92–108
High Average	109–116
High	117–125
Very High	>125

The scales have been standardised on a British sample (Griffiths, 1996); show convergent validity with the Bayley Scales of Mental Development (McClean et al. 1991; Beail, 1985); and predictive validity with the Wechsler Pre-school and Primary Scale of Intelligence (Sutcliffe, Soo, & Barnes, 2010). Good test-retest reliability of .77 (varying from 3-62 month intervals between assessments has been obtained (Griffiths, 1984) and good

inter-rater reliability of between .60 and 1.0 has been achieved in previous research (Aldridge Smith, Bidder, Gardner, and Gray, 1980).

Denver Developmental Screening Test

An adapted version of the Denver Developmental Screening Test (Frankenburg et al. 1971) was used within ALSPAC to measure early infant development at 6 months. It relates to four different categories of developmental milestones including social and communication; fine motor; hearing and speech; and gross motor skills. For example, the mother rated how often their infant would sit without support, reach for toys, make noises other than crying, lift objects or pick up small objects. Each skill was rated as occurring 'often' =3, 'once or twice' =1, or 'not yet'=0. A total development score (devised from the sum of all the questions), ranging from 0 to 126 was adjusted for the age of the infant.

Appendix D: Extended Results – Normality checks and Power Calculation

Normality checks

Before proceeding with statistical analysis, data for the independent and dependent variables (infant development at 18 months, paternal responsiveness at 12 months and paternal low mood at 18 months) were checked for normal distribution. Looking at the shape of the distribution visually (Figures D1 and D2), infant development and paternal responsiveness data appeared to be fairly normally distributed. Skewness and kurtosis analyses produced reassurance that these variables are likely to be normally distributed (Table D6). Table D1 and Figure D3 show that fathers' scores on the EPDS were significantly negatively skewed (indicating fathers were more likely to report fewer symptoms of depression), showing a statistically significant lack of normality.

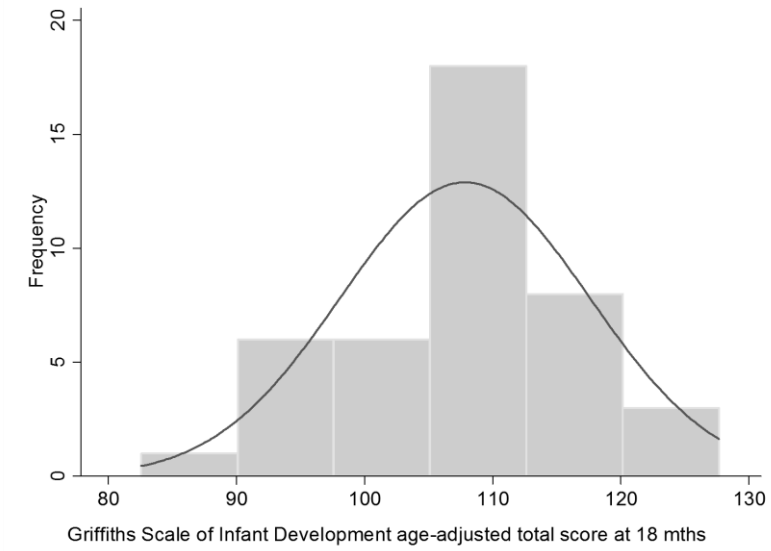

Figure D1. *Histogram of infant development data at 18 months (age-adjusted total development score on Griffiths Scale of Infant Development)*

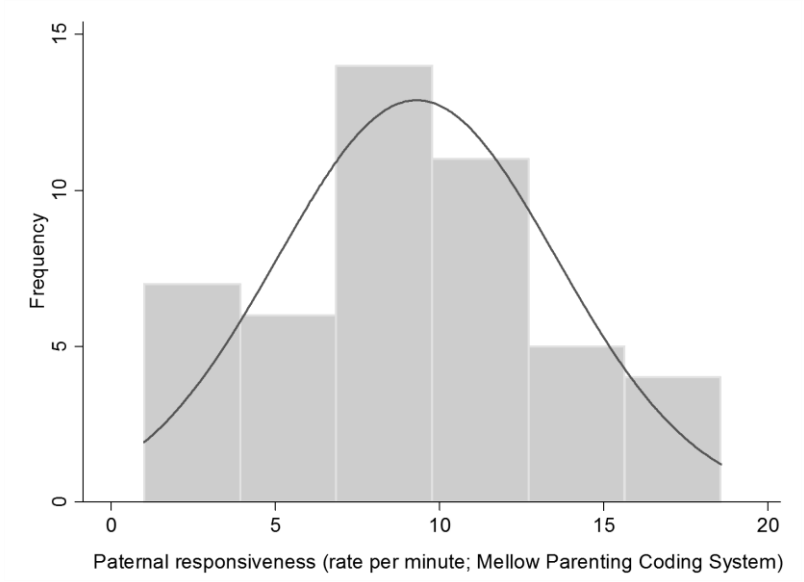

Figure E2. *Histogram of paternal responsiveness at 12 months.*

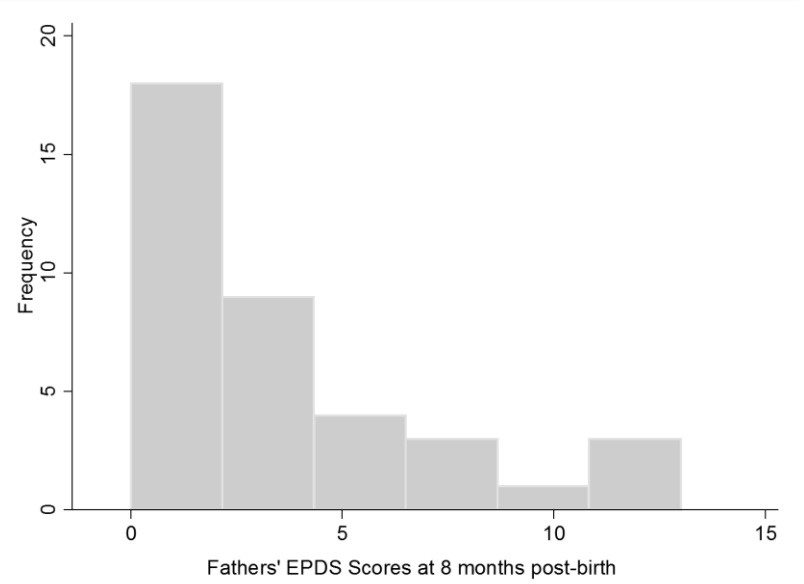

Figure D3. *Histogram of fathers' EPDS scores*

Table D1

Normality of the independent and dependent variables: Skewness and Kurtosis Statistics

	Skewness		**Kurtosis**		**Joint**	
	Statistic	p level	Statistic	p level	Adjusted Chi2	p level
Infant	-0.4219107	.2184	3.068257	.5799	1.93	.3804

development						
Paternal responsiveness	0.1192178	.7091	2.348356	.3385	1.10	.5764
Paternal low mood	1.131496	**.0047**	3.454606	.2917	7.91	**.0192**

Note: $p<0.05$ indicates a statistically significant lack of normality.

Power calculation

A power analysis carried out using G*Power 3.1.6 (Faul, Erdfelder, Lang, & Buchner, 2007) found that $f^2 = 0.196$ using a sample size of 42 participants ($\alpha = 0.05$; Power $(1-\beta) = 0.8$) for the single association between paternal responsiveness and infant development. This indicates that the study holds sufficient power to detect only a moderate or large effect size.

Appendix E: Edinburgh Postnatal Depression Scale (EPDS)

As you have recently had a baby, we would like to know how you are feeling. Please check the answer that comes closest to how you have felt IN THE PAST 7 DAYS, not just how you feel today.

Here is an example, already completed:

I have felt happy:
Yes, all the time
Yes, most of the time **X**
No, not very often
No, not at all

This would mean: "I have felt happy most of the time" during the past week.
Please complete the other questions in the same way.

In the past 7 days:

1. I have been able to laugh and see the funny side of things:
As much as I always could
Yes, most of the time
Not quite so much now
Definitely not so much now

2. I have looked forward with enjoyment to things
As much as I ever did
Definitely less than I used to
Rather less than I used to
Hardly at all

3. I have blamed myself unnecessarily when things went wrong
Yes, most of the time
Yes, some of the time
Not very often
No, never

4. I have been anxious or worried for no good reason
Yes, very often
Yes sometimes
Hardly ever
No, not at all

5 I have felt scared or panicky for no very good reason
Yes, quite alot
Yes, sometimes
No, not much
No, not at all

6. Things have been getting on top of me
Yes, most of the time I haven't been able to cope at all
Yes, sometimes I haven't been coping as well as usual
No, most of the time I have coped quite well
No, I have been coping as well as ever

7 I have been so unhappy that I have had difficulty sleeping
Yes, most of the time
Yes, sometimes
Not very often
No, not at all

8 I have felt sad or miserable
Yes, most of the time
Yes, quite often
Not very often
No, not at all

9 I have been so unhappy that I have been crying
Yes, most of the time
Yes, quite often
Only occasionally
No, Never

10 The thought of harming myself has occurred to me
Yes, quite often
Sometimes
Hardly ever
Never

Appendix F: Dissemination statement

This paper will be submitted for publication and peer review to the Journal of Family Psychology. Findings have already been presented at Bristol University to a group of interested researchers and will be presented to a group of local perinatal clinicians (e.g. clinical psychologists, health visitors and midwives) in the near future.