



## RESEARCH ARTICLE

**Differential susceptibility to fathers' care and involvement: The moderating effect of infant reactivity**Paul G. Ramchandani<sup>a\*</sup>, Marinus van IJzendoorn<sup>b</sup> and Marian J. Bakermans-Kranenburg<sup>b</sup><sup>a</sup>*Department of Psychiatry, University of Oxford, Warneford Hospital, Oxford, OX3 7JX, UK;* <sup>b</sup>*Centre for Child and Family Studies, Leiden University, P.O. Box 9555, 2300 RB Leiden, The Netherlands*

The differential susceptibility hypothesis suggests that children differ in their susceptibility to the influence of both positive and negative environmental factors. Children with reactive temperaments are hypothesised to be particularly susceptible to environmental influences, both for better and for worse. The present study sought to investigate whether infant temperament moderates the influence of fathers on child prosocial and problem behaviours. In a large prospective population study (Avon Longitudinal Study of Parents and Children), 5064 children were followed between the ages of six and 81 months (6¾ years). Infant temperament, child behaviours, and fathers' involvement and depression were assessed.

Although no overall moderating effect of reactive temperament was found for father involvement or depression, there was an interaction between reactivity, child gender, and father involvement. Girls with reactive temperaments were more susceptible to father involvement, showing significantly fewer problem behaviours and more prosocial behaviours when fathers were more involved, and more problem behaviours and fewer prosocial behaviours with less father involvement. The findings provide some support for the differential susceptibility hypothesis and extend existing findings to include effects of fathers' involvement on positive and negative behavioural outcomes.

**Keywords:** fathers; temperament; differential susceptibility; depression; ALSPAC

**Introduction**

The influence of parents on their children's development has been one of the most studied and debated areas of study in developmental psychology. The influences are far from straightforward, with genetic effects, gene-environment interactions, child-to-parent effects, and the impact of shared environmental influences on both parents and children, all affecting and complicating the findings of many studies (see Bakermans-Kranenburg & van IJzendoorn, 2010). Nonetheless, the quality and style of parenting have repeatedly been found to predict later child outcome. The importance of parental care is also supported by evidence from trials that have tested interventions with parents of young children or with expectant parents (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2008; Olds, Sadler, & Kitzman, 2007; Shaw, Dishion, Supplee, Gardner, & Arnds, 2006), and is of particular significance because many of these parenting capacities are potentially modifiable (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003; Sanders, 1999; Webster-Stratton, 1982).

In recent years, a number of studies have reported findings which suggest that some children are more susceptible than others to a range of environmental influences, including parental care and involvement. Many of the earliest examples of this work have been guided and interpreted in

the light of the prevailing diathesis-stress model, with a focus on the adverse outcomes of adverse effects on vulnerable children's development. However, this overlooks a critical alternative aspect, an increased sensitivity to the potentially positive impact of positive parenting effects on susceptible children's development (see Pluess & Belsky, 2010; for a fuller consideration of this).

This conception, described by Belsky as the "Differential Susceptibility Hypothesis" (Belsky, 1997) suggests that some children, most notably those with a reactive temperament, are more likely to be affected by environmental influences than less reactive children. This is different from the well-established idea, alluded to in the diathesis-stress model, that some children are more vulnerable to risks than other children, in that differential susceptibility suggests that some children are *not only* more adversely affected by negative environmental influences (including rearing influences), *but are also* more positively affected by positive environmental influences (Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007; Belsky & Pluess, 2009a; Boyce & Ellis, 2005).

Early examples of research, which support this hypothesis, were concerned with the prediction of externalising problems in children. Belsky, Hsieh, and Crnic (1998) found that children who displayed more negative

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emotionality at age one year, showed stronger correlations between parenting deficits and both externalising and inhibited behaviour at the age of three years, suggesting that the children with greater negative emotionality were more susceptible to the influence of parental care. Subsequent studies have shown similar moderating influences between harsh discipline and externalising problems for children with high levels of fear (Colder, Lochman, & Wells, 1997).

Far fewer studies have investigated the possibility of differential susceptibility in relation to positive effects of more optimal parenting. Such evidence is required if the hypothesis is to be accepted. Klein Velderman, Bakermans-Kranenburg, Juffer, and van IJzendoorn (2006) demonstrated in an intervention study that highly reactive children benefited most from an attachment-based video-feedback intervention designed to improve the sensitivity of parenting (VIPP; Juffer, Bakermans-Kranenburg, & van IJzendoorn, 2008). A further study found that children with more difficult temperaments were more susceptible to the effects of both negative and positive maternal discipline, with externalising problems as the outcome for the child (van Zeijl et al., 2007). Bradley and Corwyn (2008) found that children with more difficult temperaments were more susceptible to the influence of sensitive maternal parenting, showing a decrease in the levels of externalising problems, while children with an easy temperament did not. Finally, Kochanska, Aksan, and Joy (2007) found that child fearfulness moderated the association between both positive mother-child relationships and later successful socialisation and paternal discipline style and child rule-governed behaviour, with more fearful children being apparently more susceptible to the effect of positive interactions with their mothers and their fathers discipline style. Most of the research highlighted above has focused on the differential susceptibility of children to the influence of maternal behaviour. Taken together the findings provide some support for the notion that children with difficult or reactive temperaments do show an increased susceptibility to maternal influence. However, it remains unclear whether similar processes may operate in relation to the influence of fathers.

In recent years, there has been an increasing interest in the role of fathers in children's development (Lamb, 2004; Phares, Fields, Kamboukos, & Lopez, 2005). Clear evidence is emerging of associations between paternal care and involvement in children's lives and more positive developmental outcomes (Sarkadi, Kristiansson, Oberklaid, & Bremberg, 2008). These outcomes include, but are not limited to, positive peer relationships, better educational outcomes, and reduced risks of crime and antisocial behaviour. As well as the level of involvement, the quality of interaction is also predictive of later outcomes (Trautmann-Villalba, Gschwendt, Schmidt, & Laucht, 2006). However, paternal care and involvement is

not inevitably positive, and where the ability of fathers to care for their children is affected, for example, by illness, children may exhibit subsequent problems in their functioning and development. An example of this is depression, where it is now apparent that depression affecting fathers is associated with an increased risk of behavioural problems in their children (Kane & Garber, 2004; Ramchandani et al., 2008). Much remains to be learned about the effects of paternal depression, including delineation of the mechanisms by which increased risk is transmitted from parents to children.

In addition, there has been limited research to date examining whether some children are more susceptible to the effects of paternal depression. There is reason to suspect that some children might be – either because of the presence of difficult or reactive temperamental characteristics, or because of the child's gender. Boys may be more vulnerable to the effects of paternal depression than girls in the early years (Ramchandani, Stein, Evans, & O'Connor, 2005). In contrast, a lack of involved parenting from fathers in later development may impact particularly on girls as they reach adolescence (Flouri & Buchanon, 2003). In the wider child development literature, a significant body of research suggests that there are differential effects of both parental depression and other parenting variables between boys and girls (Crick & Zahn-Waxler, 2003). Thus the investigation of possible differences in impacts upon boys and girls is warranted.

### *The current study*

This study sets out to address some of these neglected research areas by testing the differential susceptibility hypothesis in relation to the reactivity of children's temperament measured in infancy. It specifically examines whether paternal factors, both positive (increased father involvement) and negative (paternal depression), have an influence on both positive (prosocial behaviour) and negative (emotional and behavioural problems) child outcomes over the first six years of life.

To do this, we considered the five steps for testing differential susceptibility set out by Belsky and colleagues (Belsky et al., 2007; Belsky & Pluess, 2009b; Belsky et al., 2009). First, there has to be a test for interaction; second, a test for whether the susceptibility factor and predictor are independent; third, a similar test of association between susceptibility factor and the outcome variable; fourth, a graphical plot of the regression should be compared with the existing examples of differential susceptibility; fifth, the model should be tested to see if other susceptibility factors and outcomes lead to similar or different findings. In this instance we used two outcome measures, prosocial behaviour and behavioural problems.

## Method

### Participants

Fathers and children participated in the Avon Longitudinal Study of Parents and Children (ALSPAC; Golding, Pembrey, & Jones, 2001). This is a large, population-based longitudinal study, centred on the city of Bristol, UK. The initial ALSPAC sample consisted of 14,541 pregnant women. There were 14,062 live births and 13,988 children were alive at one year. Questionnaires were sent to mothers and fathers at regular points during and after pregnancy. All participants provided informed consent, and ethical approval was obtained from the ALSPAC Law and Ethics Committee and Local Research Ethics Committees. Data were available for infant temperament for 11,365 children; paternal involvement 10,600; paternal depression 8431; and final child outcome at age 6¾ years for 8401. There were data available at all time points for 5064 children. This is the number included in the regression analyses. As in other studies, the final sample for this study was found to differ from the original ALSPAC cohort, with included families having fathers and mothers who were more involved in parenting, fathers with lower levels of depressive symptoms, and children with lower problem scores on the SDQ. None of these differences were large in magnitude, and there were no differences found for prosocial behaviours.

### Procedures and measures

Infant temperament was assessed when the child was six months, paternal depression at eight months, parental involvement at 21 months, and child prosocial behaviour and total emotional and behavioural problems at 81 months (6¾ years). The earliest available measure of infant temperament was used in order to minimise the impact of paternal influence on infant temperament. Paternal depression was also measured at a later time point but use of a later time point for depression led to significant loss of data because of attrition from the study, and as there is significant stability in this measure over time, the earlier time point was selected. ( $r = 0.55$  from eight to 21 months, and odds of remaining high scoring at 21 months = 32.22 (95% confidence interval 21.87, 47.47).

*Infant temperament.* This was measured when the infant was six months old with the Infant Temperament Questionnaire (Carey & McDevitt, 1978). This is a well-established, widely used measure, developed from the work of Thomas and Chess (1977), distinguishing nine domains of temperament (activity, adaptability, approach, distractibility, intensity, mood, persistence, rhythmicity, and threshold). Eleven of the questions in the scales were not used in the ALSPAC study because of poor response rate in pilot work. Parents completed each question using a 6-point scale response, from “almost never” to “almost

always.” Each question addresses a particular behaviour or characteristic. The scale has previously demonstrated test-retest reliability and internal consistency (Carey & McDevitt, 1978). In order to minimise the possibility of chance findings due to repeated statistical testing we selected one temperamental characteristic (infant reactivity), a priori for the present study, drawing on the factor identified as reactivity. This factor seems to index the underlying reactivity of the neural systems and, as such, reflects the evolutionary characteristic identified by Belsky in the differential susceptibility theory and used in previous published work (Belsky et al., 2007; Belsky et al., 2009). It bears some relation to the approach of Kagan and Snidman (2004) in considering temperament as differences in the reactivity of underlying neural systems, and is related to the category of negative affectivity described by Rothbart and colleagues (Rothbart, Ahadi, Hershey, & Fisher, 2001). A scale to assess infant reactivity was created by calculating the average of the z-scores for the intensity and threshold scores, following the work of Curtindale et al. (Curtindale, Laurie-Rose, Bennett-Murphy, & Hull, 2007). The alpha coefficient for the reactivity scale was 0.58, which is similar to that found in previous investigations with older children (Curtindale et al., 2007).

*Parental involvement.* At 18 months, mothers were asked how often they undertook 10 activities with their child. They were separately asked how often their partner undertook the same activities with their child. The activities were: bathing the child, feeding him/her, singing, reading, playing with toys, cuddling, playing pat-a-cake, physical play, taking him/her for walks, and any other activities. Responses were on a 5-point scale, from never, to every day.

*Paternal depression.* The Edinburgh Postnatal Depression Scale (EPDS) was completed by fathers. The EPDS is a well-validated, widely used, self-report questionnaire that consists of 10 items. Although the EPDS was developed to screen for depression in women postnatally, it has also been validated in men (Matthey, Barnett, Kavanagh, & Howie, 2001).

*Prosocial and problem behaviour in children.* This was assessed using the Strengths and Difficulties Questionnaire (SDQ), which was completed by mothers. It is a widely used and validated screening questionnaire and high scores are associated with a substantially increased risk of psychiatric disorder (Goodman, 2001). It consists of 25 questions which divide into five subscales (emotional problems, hyperactivity, conduct problems, peer problems, and prosocial behaviour). The first four subscale scores combine to give a total problems score. In the present study the prosocial and total problems scores were used as the main child outcome measures. They both have high internal consistency in this sample (0.72 and 0.80, respectively).

### Analysis plan

Two separate multiple regression analyses were conducted initially, with total problems scores and prosocial scores as the outcomes. Prior to constructing the models all variables to be entered into interaction models were centered (i.e., sample means were subtracted from the individual scores) to avoid problems of multicollinearity (Aiken & West, 1991).

A four-step multivariate linear regression model was constructed, with father's highest educational level and mothers involvement score entered at step 1. Mothers' involvement scores were entered into the analyses to control for possible maternal reporting bias, as mothers were the reporters for both fathers' involvement and child outcomes. At step 2 the two main predictors (father involvement and father depression) and the hypothesised moderator (infant reactivity), as well as child gender were entered, and at step 3 two-way interactions of father involvement and both infant reactivity and gender were entered, as were the two-way interactions of father depression and both infant reactivity and gender. At step 4 three-way interactions between father involvement, infant reactivity and gender, and father depression, infant reactivity, and gender were entered.

As reactivity was weakly correlated with father involvement and with prosocial and problem behaviour, we then re-ran the analyses having regressed reactivity onto these variables, and used the residuals of these three variables in the analyses to control for any correlation.

Where significant gender interactions were found, we subsequently ran regression models for boys and girls separately.

### Results

There were 2586 boys and 2478 girls in the sample. There were no gender differences for father's involvement, depression, or educational level. Maternal involvement scores were higher for girls, as were prosocial scores and infant reactivity. Total behavioural difficulty scores were higher in boys (see Table 1).

Infant reactivity at six months was found to be correlated with father involvement ( $r = .06; p < .01$ ) and paternal depressive symptoms ( $r = .03; p = .04$ ). The correlations between infant reactivity and outcomes at age six years were of a similar magnitude (prosocial behaviours  $r = .09; p < .01$ ; total problems  $r = .03; p = .03$ ). All inter-item correlations are shown in Table 2.

#### Main associations of father involvement and depression with prosocial and problem behaviours

For prosocial behaviour main effects were found at step 2 of the regression (controlling for maternal involvement

Table 1. Main variables used in the study, split by gender.

Variable	Male	Female
	( <i>n</i> = 2586)	( <i>n</i> = 2478)
Paternal education – % with degree	25.7%	24.2%
Paternal depression – mean ( <i>SD</i> )	3.19 (3.50)	3.26 (3.65)
Paternal care and involvement – mean ( <i>SD</i> )	24.90 (6.22)	25.14 (6.13)
Maternal care and involvement – mean ( <i>SD</i> )	40.53 (4.49)	41.28 (4.15)*
Infant reactivity – mean ( <i>SD</i> )	–0.06 (0.82)	0.01 (0.82)*
Prosocial behaviour – mean ( <i>SD</i> )	7.85 (1.85)	8.51 (1.59)*
Total problems score – mean ( <i>SD</i> )	7.72 (4.85)	6.70 (4.40)*

\*Different from scores for male children ( $p < .01$ ).

score, infant gender, and paternal educational level) for father involvement ( $\beta = .06; p < .01$ ), father depression ( $\beta = -.06; p < .01$ ), and infant reactivity ( $\beta = .07; p < .01$ ). Higher levels of father involvement predicted more prosocial behaviours in children, whereas higher levels of paternal depression predicted less prosocial behaviour in children.

Main effects were also found for total behavioural problems at step 2 of the regression (controlling for maternal involvement score, infant gender, and paternal educational level), for father involvement ( $\beta = -.11; p < .01$ ), father depression ( $\beta = .10; p < .01$ ), and infant reactivity ( $\beta = .04; p < .01$ ). Higher levels of father involvement and lower levels of father depression predicted fewer behavioural problems in children.

#### Moderating effects of infant reactivity

To test the differential susceptibility hypothesis, we subsequently introduced the two-way interaction terms of both father involvement and paternal depression with infant gender and reactivity and then the three-way interactions of infant reactivity and gender with father involvement. For prosocial behaviour, the addition of the two-way interaction terms did not significantly improve the model; however, the addition of the three-way interactions did ( $R^2$  change = 0.001,  $F$  change [2, 5050] = 3.37,  $p = .03$ ). In this final model (shown in Table 3) a significant three-way interaction between father involvement, infant reactivity, and gender was found ( $\beta = .03, p = 0.02$ ). Further exploration revealed that in more temperamentally reactive girls, greater father involvement predicted higher prosocial scores at age  $6^{3/4}$  years, and lower levels of father involvement predicted lower prosocial scores (Figure 1), whereas in boys the effect tended to be in the opposite direction. No interactions between paternal depression and infant reactivity were found.

We repeated the same analyses for total behavioural problems. Here again, the addition of the two-way interaction

Table 2. Correlations of variables.

	Paternal Education	Paternal Depression	Paternal Involvement	Maternal Involvement	Infant Reactivity	Prosocial Scores (SDQ)	Total Problems (SDQ)
Paternal education	25.0% degree	-.003	.154*	.103*	-.006	-.032	-.073*
Paternal depression		4.8% depressed	-.072*	-.036	.029	-.065*	.106*
Paternal involvement			mean 24.90 SD 6.20	.350*	.055*	.099*	-.133*
Maternal involvement				mean 40.88 SD 4.34	.130*	.135*	-.087*
Infant reactivity					mean 52.35 SD 9.54	.092*	.031
Prosocial behaviour						mean 8.18 SD 1.76	-.396*
Total problems							mean 7.27 SD 4.68

\* $p < .01$ .

Table 3. Summary of hierarchical regression analysis for predictors of prosocial behaviours at age 6<sup>3</sup>/<sub>4</sub> years ( $N = 5064$ ).

Predictor variables	B	$\beta$	$t$	$p$
<b>Step 1</b>				
Partners educational level	-.060	-.046	-3.320	.001
Mother involvement (parenting score)	.057	.140	10.020	<.001
<b>Step 2</b>				
Gender	.616	.175	12.816	<.001
Father involvement (parenting score)	.018	.062	4.260	<.001
Infant reactivity	.161	.075	5.476	<.001
Father depression	-.030	-.061	-4.442	<.001
<b>Step 3</b>				
Father involvement $\times$ reactivity	-.001	-.004	-.298	.766
Father depression $\times$ reactivity	.003	.006	.319	.750
Father depression $\times$ gender	-.026	-.035	-1.899	.058
Father involvement $\times$ gender	-.015	-.026	-1.867	.062
Reactivity $\times$ gender	-.033	-.008	-.572	.567
<b>Step 4</b>				
Father involvement $\times$ reactivity $\times$ gender	.022	.033	2.341	.019
Father depression $\times$ reactivity $\times$ gender	-.014	-.015	-.800	.424

Note:  $R = 0.26$ ,  $R^2 = 0.07$ ,  $F = 27.48$   $p < 0.01$ .

terms did not significantly improve the model; however, the addition of the three-way interactions marginally did ( $R^2$  change = 0.001,  $F$  change [2, 5050] = 2.94,  $p = .05$ ). In this final model (shown in Table 4) a significant interaction between father involvement, infant reactivity, and gender was found ( $\beta = -.03$ ;  $p = .04$ ) indicating that in more temperamentally reactive girls, greater father involvement predicted fewer behavioural problems at age 6<sup>3</sup>/<sub>4</sub> years and lower levels of father involvement predicted more behavioural problems (Figure 2), whereas in

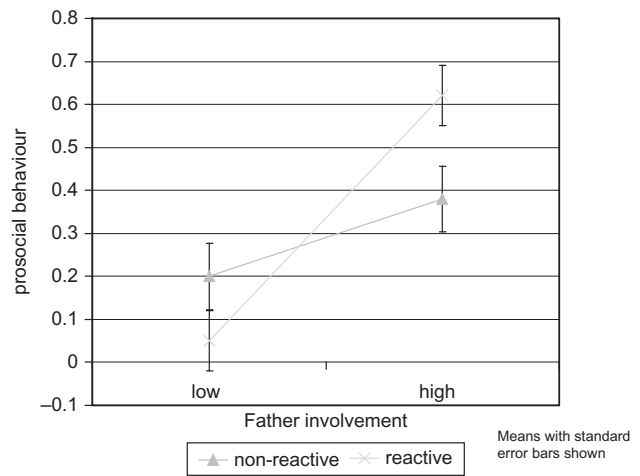


Figure 1. Association between paternal involvement and prosocial behaviour in girls: moderated by temperament.

boys infant reactivity did not moderate the association between father involvement and later total problem scores. Again, no effects for the interaction between paternal depression and infant reactivity were found.

These models were then repeated using the residualised predictor and outcome scores, to control for correlations between infant reactivity and paternal involvement, prosocial behaviours, and total problem scores. No changes to the outcomes regarding the interactions were seen. When regression models were subsequently run separately for boys and girls to assess the associations with father involvement, we found a significant interaction with reactive temperament in girls for total behavioural problems ( $\beta = -.05$ ;  $p = .01$ ), but not for prosocial behaviours ( $\beta = .03$ ;  $p = .13$ ). In boys, no interactions were found for either problem behaviours ( $\beta = .01$ ;  $p = .61$ ) or prosocial behaviours ( $\beta = -.04$ ;  $p = .08$ ). When the models were rerun with

Table 4. Summary of hierarchical regression analysis for predictors of total problem behaviours at age 6¾ years (*N* = 5064).

Predictor variables	B	$\beta$	<i>t</i>	<i>p</i>
<b>Step 1</b>				
Partners educational level	-.221	-.064	-4.571	<.001
Mother involvement (parenting score)	-.086	-.080	-5.709	<.001
<b>Step 2</b>				
Gender	-.999	-.107	-7.760	<.001
Father involvement (parenting score)	-.079	-.105	-7.063	<.001
Infant reactivity	.206	.036	2.608	.009
Father depression	.127	.097	7.040	<.001
<b>Step 3</b>				
Father involvement × reactivity	-.017	-.019	-1.357	.175
Father depression × reactivity	.015	.012	.649	.516
Father depression × gender	.030	.015	.832	.405
Father involvement × gender	.005	.004	.259	.796
Reactivity × gender	.089	.008	.566	.571
<b>Step 4</b>				
Father involvement × reactivity × gender	-.051	-.029	-2.028	.043
Father depression × reactivity × gender	.048	.020	1.044	.297

Note: *R* = 0.22, *R*<sup>2</sup> = 0.05, *F* = 18.83, *p* < 0.01.



Figure 2. Association between paternal involvement and behavioural problems in girls: moderated by temperament.

paternal depression removed, and so with a larger sample size (*n* = 7256), similar, but more robust findings emerged, with a significant interaction between father involvement and infant reactivity in girls for both total behavioural problems ( $\beta$  = -.04; *p* = .01) and prosocial behaviours ( $\beta$  = .04;

*p* = .01). In boys, no interactions were found for either problem behaviours ( $\beta$  = .00; *p* = .90) or prosocial behaviours ( $\beta$  = -.01; *p* = .49). Finally, we ran regression models with both paternal education and maternal involvement removed, as they could be related to the processes of interest. The findings were essentially unchanged with minimal variation in the beta values seen (<0.003).

**Discussion**

The findings of this study indicate that, compared to less reactive girls, those girls who had more reactive temperaments as infants are more susceptible to the effects of increased care and involvement from their fathers, with evidence of fewer problem behaviours and more prosocial behaviours with increasing father involvement, and both greater problem behaviours and fewer prosocial behaviours with less father involvement. Although boys showed positive benefits of paternal involvement overall, they showed no evidence of differential susceptibility by reactive temperament. The findings of possible differential susceptibility for children who had been more reactive as infants were therefore specific to female children. They were also specific to father care and involvement, as there was no evidence found for differential susceptibility to paternal depression. Before considering potential implications of these findings in detail, we first consider the strengths and weaknesses of the present investigation.

This study has a number of strengths. First, the participants are drawn from a large unselected population cohort study, and so the findings are relatively free from the selection biases associated with clinical or experimental samples. Second, the data for this longitudinal study were collected prospectively over the course of six years; with infant temperament (moderator) information collected at age six months, exposure information (parental involvement and paternal depression) in the two years following this, and the child outcomes at age 6¾ years. Third, most of the measures used (e.g., Strengths and Difficulties Questionnaire, Edinburgh Postnatal Depression Scale, Carey Infant Temperament Questionnaire) have been validated extensively.

There are a number of limitations to consider. First, there was significant attrition of the sample through the course of the study over more than six years, with some evidence of selective attrition on factors such as paternal depression, and so there is a possibility that these findings may not all generalise to the entire population because of bias. Second, all measures were by questionnaire, with no directly observed measures. Several of the measures were by maternal report and it is possible that this led to greater correlation between the variables. This problem is tempered somewhat by the large amount of time that had passed between the assessments for temperament and

child behaviour (six years), supported by the finding of only small correlations between the moderator and outcome measures. Nonetheless, observational measures would be a methodological improvement (Kagan, 2009). Third, although there was clear evidence of an interaction between father involvement and reactive temperament for problem behaviours in girls, the evidence for prosocial behaviours was slightly weaker. Finally, the interaction effects found are relatively small, although statistically significant and theoretically expected, and some caution should thus be used in considering their implications. The size of the effects may be influenced in part by the modest level of reliability of the infant reactivity measure, which is likely to have led to a decrease of the effect sizes seen overall. It should be noted that no absolute criteria for evaluation of effect sizes exist and seemingly small effects might be practically and theoretically important (McCarty & Rosenthal, 2000).

The findings of this study do add cautiously to a growing body of research that provide support for the concept of differential susceptibility, that is, some children are temperamentally more likely to be affected by environmental influences (in this case, father care and involvement) than other children. This study has extended the findings of previous work in two important directions. First, there has been extremely limited previous research investigating the possibility of differential susceptibility in relation to the influence of fathers, as opposed to mothers (Kochanska et al., 2007). The last two decades have seen a substantial increase in interest in the role of fathers in children's lives (see, for example, Lamb, 2004). However, much of this focus has followed the potential influence in older children, with more limited focus on the role of fathers early in their children's lives. The second way in which the present study extends previous research is in assessing the interactions between reactive temperament and paternal care and involvement for both positive and negative outcomes. Most previous research has focussed on negative behaviours (e.g., externalising behaviour problems) whereas we have had the opportunity to also explore prosocial behaviour.

The fact that the interactions with reactive temperament were limited to girls warrants cautious interpretation until such findings are replicated. There is conflicting evidence regarding the impact of father involvement on boys and girls with many studies showing few gender differences. However, some previous work has shown that girls may be particularly influenced by their father's involvement compared to boys, with girls showing a stronger negative correlation between father involvement and mental health difficulties following adolescence (Flouri & Buchanan, 2003), and infant negative emotionality in interactions with their fathers predicting later externalising problems for

girls but not boys (Trautmann-Villalba et al., 2006). A differential effect of father involvement on girls' development appears to be the case particularly as they enter later childhood and early adolescence, and this may relate to differences in developmental trajectories between girls and boys, with girls entering puberty and forming romantic attachments earlier. We may speculate that a girl's early relationship with her father forms a template for her later relationships, particularly with boys, and this may influence her behavioural outcomes more than it does for boys, who may be more influenced by peer relationships with other boys until they are older.

It is also of note that in this study girls were more reactive overall (although there were no gender differences for the variability of reactivity). Higher numbers of girls with greater reactivity may have increased the power of the study to detect differential susceptibility in girls, although this factor is unlikely to account for the findings alone.

## Conclusion

These findings suggest that a reactive temperament may render girls more susceptible to the influence of their fathers' involvement in parenting, both through having fewer problem behaviours and more prosocial behaviours with increasing father involvement, and more problem behaviours and fewer prosocial behaviours with less father involvement. The fact that the findings are at present limited to one gender suggests that further investigation of this area of research is required before firm conclusions can be drawn. Nonetheless, in combination with other work a picture is beginning to emerge of the complex ways in which characteristics of individual infants interact with the environment to which they are exposed in moderating the influence that these environments exercise on child development.

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